Hhh. 1030

A TUTOR to
ASTRONOMIE and GEOGRAPHIE.

Or an Easie and speedy way to know the USE of both the

GLOBES,

Cœlestial and *Terrestrial.*

In six BOOKS.

The first teaching the Rudiments of *Astronomie* and *Geographie.*

The 2. 3. 4. 5. 6. Shewing by the Globes; the solution of *Astronomical & Geographical* Problemes in *Navigation*, *Arstological* Problemes, *Gnomonical* Problemes, *Trigonometrical* Problemes.

More fully and amply than hath yet been set forth either by *Gemma Frisius*, *Metius*, *Hues*, *Wright*, *Blaew*, or any others that have taught the Use of the Globes: And that so plainly and methodically that the meanest Capacity may at first reading apprehend it, and with a little practice grow expert in these Divine Sciences.

With an Appendix shewing the use of the *Ptolomaick Sphere.*

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The second Edition, Corrected and enlarged. By *Joseph Moxon*, Hydrographer to the Kings most Excellent Majesty.

Whereunto is added the Antient *Poetical Stories of the Stars*: shewing Reasons why the several shapes and forms are pictured on the *Celestial Globe.*

As also a Discourse of the *Antiquity, Progress and Augmentation of Astronomie.*

Job. 26 7. 13. *He stretcheth out the North over the empty place, and hangeth the Earth upon nothing. By his Spirit he hath garnished the Heavens: His hand hath framed the crooked Serpent.*

LONDON, Printed by *Joseph Moxon*: and sold at his Shop in *Russel street*, at the signe of *Atlas.* 1670.

DUCTOR ad
ASTRONOMIAM
&
GEOGRAPHIAM.
vel usus
GLOBI,
Celestis quam Terrestris.
In Libris sex,
viz.
Astron. & Geogr. Rudim.
Astrō. & Geogr.
Nautica.
Astrologica.
Gnomonica.
Sphæric. Triang.
Probl.
Per Josephum Moxon.
LONDINI, Sumptibus Josephi Moxon.

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To the Reader.

Courteous Reader,

THe Globes is the first Study a Learner ought to undertake, for without a competent apprehension of them he will not be able to understand any Author either in Astronomy, Astrology Navigation, or Trigonometry: Therefore my aim in this book hath been to make the Use of them very plain and easie to the meanest Capacities: In prosecution of which Design, I doubt the Learneder sort may be apt to Censure me guilty of Prolixity, if not Tautology: Because the precepts being plain, they may account some of the Examples Useless. But I desire them to consider that I write not to expert Practioners, but to Learners; to whom Examples may prove more Instructive than precepts. Besides, I hope to encourage those by an ample liberal plainness to fall in love with these Studies, that formerly have been disheartned by the Crabbed brevity of those Authors that have (in Characters as it were) rather writ Notes for their one Memories, than sufficient Documents for their Readers Instructions.

The Globes for which this Book is written are new Globes that I set forth; which as I told you in my Epistle to the Reader of Blaws Book differs somewhat from other Globes; and that both the Coelestial and the Terrestrial; mine being the lateſt done of any, and to the accomplishing of which I have not only had the help of all or most of the best of other Globes, Maps, Platts; and Sea-drafts of New discoveries that were then extant for the Terrestial Globe, but also the Advice and directions of divers able Mathematicians both in England and Holland for Tables and Calculations both of Lines and Stars for the Coelestial: upon which Globe I have placed every Star that was observed by Tycho Brahe and other Observers one degree of Longitude farther in the Ecliptick than they are on any other Globes: So that whereas on other Globes the places of the Stars were correspondent with their places in Heaven 69. Years ago, when Tycho observed them, and therefore according to his Rule want almost a degree of of their true places in Heaven at this Time: I have set every Star one degree farther in the Ecliptick, and Rectified them on the Globe according to the true place they will have in Heaven in the Year 1671.

On the Terrestrial Globe *I have inserted all the New Discoveries that have been made, either by our owne or Forraign Navigators, and that both in the East, West, North, and South parts of the Earth. In the* East Indies *we have in these latter Times many spatious places discovered, many Ilands inserted, and generally the whole Draft of the Country rectified and amended, even to the Coast of* China, Japan, Giloli, *&c. In the* South Sea *between the* East *and* West Indies *are scatered many Ilands, which for the uncertain knowledge former Times had of them are either wholy left out of other Globes, or else laid down so erroneously that little of credit can be attributed unto them:* California *is found to be an Iland, though formerly supposed to be part of the main Continent, whose North West shoar was imagined to thrust it self forth close to the Coasts of* Cathaio, *and so make the supposed* Straits of Anian. *The Western Shoars of the* West Indies *are more accurately described than formerly, as you may see if you compare my Terrestrial Globe that I have lately set forth with the Journals of the latest Navigators: And if you compare them with other Globes you will find 5, 6, yea 7. degrees difference in Longitude in most Places of these Coasts.* Magellanica *which heretofore was thought to be part of the South Continent called* Terra Incognita *is now also found to be an Iland. All that Tract of Land called* Terra Incognita *I have purposely omitted, because as yet we have no certainty whether it be Sea or Land; unless it be of some parts lately found out by the Dutch; who having a convenient Port at* Batavia *in* Java *have from thence sent forth Ships Southwards, where they have found several very large Countries; one whereof they have called* Hollandia Nova, *another* Zelandia Nova, *another* Anthoni van Diemans Land; *and divers others; some whereof lies near our* Antipodes; *as you may see by my Terrestrial Globe. Again, Far to the Northwards there are some New Discoveries, even within 6. degrees of the Pole: The Drafts to the* North Eastwards *I have laid down even as they were described by the Searchers of those parts, for a passage into the* East Indies. *And also the Discoveries of* Baffin, *Capt.* James, *and Capt.* Fox, *(our own Country men, that attempted the finding a passage that way into the South Sea.*

I also told you what difference there is in several Authors about placing the first Meridian, which is the beginning of Longitude;

gitude; that Ptolomy *placed it at the* Fortunate Ilands, *which Mr* Hues pag. 4. chap. 1. *in his Treatiſe of Globes proves to be the Ilands of* Cabo Verde, *and not thoſe now called the* Canary Ilands; *becauſe in his Time they were the fartheſt places of the Diſcovered World towards the ſetting of the Sun*: Others *placed it at* Pico *in* Teneriffa; Others *at* Corvus *and* Flora; *becauſe under that Meridian the Compaſs had no* Variation, *but did then duly reſpect the North and South*; Others *for the ſame Reaſon began their Longitude at St* Michales; *and others between the Ilands of* Flores *and* Fayal: *And the Spaniards of late by reaſon of their great Negotiation in the* Weſt Indies, *have begun their Longitude at* Toledo *there, and contrary to all others account it Weſtwards.*

Therefore I ſeeing ſuch diverſity among all Nations, and as yet an Uniformity at home, choſe with our own Country men to place my Firſt Meridian at the Ile Gratioſa, *one of the Iles of* Azores.

By the different placing of this firſt Meridian it comes to paſs that the Longitude of places are diverſly ſet down in different Tables: For thoſe Globs or Maps that have their firſt Meridian placed to the Eaſtwards of Gratioſa *have all places counted Eaſtward between the firſt Meridian and the Meridian of* Gratioſa *in fewer degrees of Longitude: And thoſe Globes and Maps that have their firſt Meridian placed to the Weſtwards, have all places counted Eaſtwards from the Meridian of* Gratioſa *and their firſt Meridian in a greater number of degrees of Longitude, and that according as the Arch of Difference is.*

As an Appendix to this Book I have added a deſcription of the Ptolomaick Sphears, *and have inſerted ſome particular Problemes of its uſe: together with inſtructions how the whole uſe of that Sphear may eaſily be known by this Book.*

I have alſo annexed a ſmal Collection out of Dr Hood, *which declares the Reaſons why ſuch ſtrange Figures, and Forms are pictured on the Cœleſtial Globe: and with all the Poetical Stories of every Conſtellation.*

I likewiſe thought good to add at the latter end of this Book a ſmal Treatiſe, intituled The Antiquity, Progreſs, and Augmentation of Aſtronomy. *I may without Partiallity give it the Encomium of a Pithy, Pleaſant, and Methodical peece: It was written by* Gaſſendus, *and is worthy the Perruſal of all Ingenious Lovers of theſe Studies.*

Joſeph Moxon.

The First BOOK,

Being the first RUDIMENTS *of*

Astronomie *and* Geographie.

Or

A Description of the Lines, Circles, *and other Parts of the*

GLOBES.

PRÆFACE.

THe *Studients of all Arts and Sciences have ever proposed a Maxime, whereon (as on an allowed Truth) the whole Science hath dependance: and by so much the more demonstrable that Maxime is, so much the more of Excellency the Science may claim.*

This of Astronomie *and* Geographie *comes not behind any: for herein we shall only admit (with the Ancients) that the Form of the visible World is* Spherical: *Neither shall we beg our Ascertion any further than* Occular *Appearance will demonstrate: every Mans Ey being his Iudge, if he be either on a Plain field, or at Sea, where nothing can hinder a free inspection of the* Horizon.

Upon good grounds therefore, they asserted the Spherical form of the Whole: and also concluded the Parts to be Round: I mean every intire Subsistance, as the Stars, Planets, *and the* Earth. *In the* Celestial Bodies *(as the* Stars *and* Planets) *this is also visible; and therefore un-controullable: But that the Earth is Rouud proves with the unskilfull matter of di-*

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ſpute; they frequently objecting with S. Auſtine the words of the Scripture, which ſay, He hath ſtretched forth the Corners of the Earth; not conſidering whether thoſe words were ſpoken as alluding to the amplitude of Gods Omnipotence, or that the Corners were meant Capes of Land, which indeed are ſtretched forth into the Sea. But that the Earth is Round is proved by divers certain and infallible Reaſons,

As firſt, By the Navigations of our Age, Divers able and honeſt Mariners having Sailed and continued an Eaſterly Courſe, have at length arrived (without turning back) to the ſame place from whence they ſet forth: witneſs Magellanicus, Sr. Francis Drake, Tho. Cavendiſh, Oliver vander Noort, W. Schouten, &c.

Secondly, By the length of degrees in every Parallel; for it is found by Dayly obſervation that the degrees of every Parallel upon the Earth, hold the ſame proportion to the degrees of the Equinctial, as the degrees of the ſame Parallel upon an Artificial Globe or Sphere do to the degrees of the greateſt Circle of the ſame: This argument alone is ſufficient: yet take one more from Viſible Appearance: And that is this: The ſhadow which the Earth and Water together make in the Eclipſe of the Moon is alwaies a part of a Circle; therefore the Earth and Water which is the Body ſhadowing muſt alſo be a Circular or round Body; for if it were three ſquare, four ſquare, or any other forme, then would the ſhadow which it makes in the Moon be of the ſame faſhion.

Beſides, Of all figures the Sphere or Globe is moſt perfect, moſt Capacious, and moſt intire of it ſelf, without either joynts or Angles; which forme we may alſo perceive the Sun, Moon, and Stars to have, and all other things that are bounded by themſelves, as Drops of Water, and other liquid things.

But there is another frequent Argument againſt the Globulus form of the Earth; and that is, That it ſeems impoſſible that the Earth ſhould be round, and yet alſo Inhabitable in all Places:

Places: For though we that inhabite on the top of the Earth go with our heads upwards; yet thoſe that inhabite underneath us muſt needs go with their Heads downwards, like Flyes on a Wall or Ceeling; and ſo be in danger of falling into the Air.

For Anſwer hereunto, firſt, You muſt underſtand that in the Center of the Earth there is an Attractive and drawing power, which draws all heavy ſubſtances to it: by vertue of which Attractive power, things though looſed from the Earth will again incline and cling to the Earth, and ſo much the more forcibly, by how much the heavier they are; as a bullet of Lead let fall out of the Air, inclines towards the Earth far more violently and ſwiftly then a bullet of the ſame bigneſs of Wood, or Cork.

Secondly, you muſt underſtand that in reſpect of the whole Vniverſe there is no part either upper or under, but all parts of the Earth are alike incompaſt with Heaven; yet in reſpect of the Earth, it is Heaven, which we take for the upper part: and therefore we are ſaid to go with our heads upwards, becauſe our head (of all the parts of our body) is neareſt to Heaven.

Now that this Attractive power lies in the Center of the Earth, is proved by this Argument: If the Attractive power were not in the Center, a Plumb-line let fall would not make Right Angles with the Superficies of the Earth; but would be Attracted that way the Attractive vertue lies, and ſo make unequall Angles with the Superficies: But by ſo many Experiments as hath yet been made, we find that a Plumb-line continued, though never ſo deep, yet it alters no Angles with the Superficies of the Earth; and therefore undoubtedly the Attractive power lies in the very Center, and no where elſe.

CHAP. I.

Sect. I. *What a* Globe *is.*

A Globe according to the Mathematical Definition, is a perfect and exact round Body, contained under one surface.

Of this form (as hath been proved) consists the Heavens and the Earth: and therefore the Ancients with much pains Study and Industry, endeavoring to imitate as well the imaginary as the real appearances of them both, have Invented two Globes; the one to represent the Heavens, with all the Constellations, fixed Stars, Circles, and Lines proper thereunto, which Globe is called the *Cœlestial Globe*; and the other with all the Sea Coast, Havens, Rivers, Lakes, Cities, Towns, Hills, Capes, Seas, Sands, &c. as also the Rumbs, Meridians, Parallels, and other Lines that serve to facilate the Demonstration of all manner of Questions to be performed upon the same: and this Globe is called the *Terrestrial Globe.*

§ II. *Of the two* Poles.

Every Globe hath two Poles, the one North, and the other South, The North Pole is the North point of the Globe: The South Pole in the South point.

§ III. *Of the* Axis.

From the Center of the Globe both waies proceeds a line through both the Poles, and continues it self infinitely; which is called the *Axis of the World*, and is represented by the two wyers in the Poles of the Globe: Upon these two wyers the Globe is turned round, even as the Heavens is imagined to move upon the *Axis* of the World.

§ IIII. *Of the* Brasen Meridian.

Every Globe is hung by the *Axis* at both the Poles in a Brasen Meridian, which is divided into 360 degrees; (or which is all one) into 4 Nineties: the first beginning at the North Pole, is continued from the left hand towards the right till the termination of 90 degrees, and is marked with 10, 20, 30, &c. to 90. from whence the degrees are numbred with 80, 70, 60, &c. to 0. which is in the South Pole: from whence again the degrees are numbred with

with 80, 70, 60, &c. to 0. and lastly from 0 the degrees are numbred with 10, 20, 30, to 90. which is again in the North Pole.

This Brasen Meridian is of great use; for by the help of it you may find the Latitude of all places, the Right Ascension and Declination of all the Stars, &c. and Rectifie the Globe to any Latitude.

§ V *Of the* Horizon.

The Horizon is a broad wooden Circle, encompassing the Globe; having two notches in it; the one in the North, the other in the South point: The notches are made just fit to contain the Brasen Meridian that the Globe is hung in: In the bottom or under Plain of the Horizon there stands up a prop or (as it is called) a *Bed*, in which there is also a notch, into which notch the Brasen Meridian is also let, so low as that both it and the Globe may be divided into two equal halfs by the upper Plain of the wooden Horizon. These Notches are as gages to keep the Globe from inclining more to the one side of the wooden Horizon than the other.

Upon the upper Plain of the Horizon is several Circles delineated: as first, the inner Circle, which is a Circle divided into twelve equal parts, viz. into twelve Signes, every Signe having its name prefixed to it, as to the Signe of ♈ is the word *Aries*; to ♉ the word *Taurus*, &c. every Signe again is divided into 30 equal parts which are called Degrees, and every tenth degree is marked with 10, 20, or 30.

Next to the Circle of Signes is a Kalender or Almanack, according to the Old stile used by us here in *England*, each Moneth being noted with its propper name; as *January*, *February*, *March*, *&c.* and every day distinguished with Arithmetical figures, as 1, 2, 3, 4, &c. to the end of the Moneth.

The other Calender is a Calender of the New style; which is in a manner all one with the Old; only in this Calender the Moneth begins ten daies sooner than they do in the other: and to this Calender (because it was instituted by the Church of *Rome*) there is annexed the Festival daies Celebrated by the Romish Church.

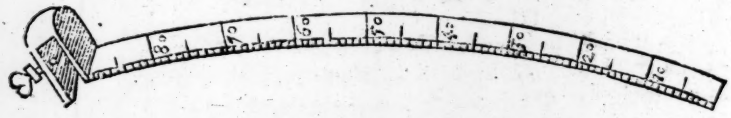
The two other Circles are the Circles of the Winds; the innermost having their Greek and Latine names, which by them were but twelve; and the outermost having the English Names, which for more preciseness are two and thirty.

The use of the upper Plain of the Horizon is to distinguish the Day from the Night; the Rising and Setting of the Sun, Moon, or

Stars, &c. and for the finding the Azimuth, and Amplitude, &c.

§ VI. *Of the* Quadrant *of* Altitude.

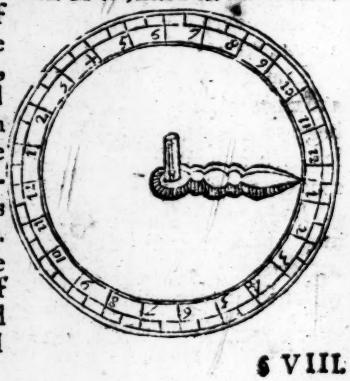
The Quadrant of Altitude is a thin braſs plate, divided into 90. degrees; and marked upwards with 10,20,30,40, &c. to 90. It is rivetted to a Braſs Nut, which is fitted to the Meridian; and hath a Screw in it, to ſcrew upon any degree of the Meridian When it is uſed it is moſt commonly ſcrewed to the Zenith. Its uſe is



for meaſuring the Altitudes, finding Amplitudes, and Azimuths, and deſcribing Almicantaraths. It would ſometimes ſtands you in good ſteed if the Plate were longer by the bredth of the Horizon than 90. degrees; for then that length being turned back will ſerve you inſtead of an Index: when the Nut is ſcrewed to the Zenith, to cut either the degrees or Daies of either Style, or the Points of the Compaſs in any of thoſe Circles concentrical to the innermoſt edge of the Horizon: which the Ey cannot ſo well judge at.

§ VII. *Of the* Hour Circle, *and its* Index.

The Hour Circle is a ſmal Braſen Circle, fitted on the Meridian, whoſe Center is the Pole of the world; it is divided into the 24. hours of the Day and Night, and each hour is again divided into halfs and quarters, which in a Revolution of the Globe are all pointed at with an Index, which to that purpoſe is fitted on the Axis of the Globe.



The uſe of the hour Circle is for ſhewing the Time of the ſeveral mutations and Configurations of Celeſtial Appearances.

§ VIII.

§ VIII. *Of the* Nautical Compass, *or* Box *and* Needle.

Just under the East point of the Horizon, upon the undermost Plain, is sometimes fixed a Nautical Compass, whose North and South line must be Parallel to the North and South line of the Horizon. The use [illegible] for setting the Angles of the Globe correspondent to the [illegible] of the World.

§ IX. *Of the* Semi-Circle *of* Position.

This is a Semi-Circle made of Brass, and divided into 180. degrees, numbred from the Equinoctial on either side with 10, 20, 30, &c. to 90. at the two ends there is an Axis, which is fitted into the two holes of two smal studs, fixed in the North and South line of the upper Plain of the Horizon: upon this Axis it is moved up and down, according to the intent of your operation.

The use of this Circle of Position is, for the finding the twelve Astrological Houses of Heaven; and also for finding the Circle of Position of any Star or Point in Heaven.

Thus much may serve for the lineaments circumjacent to the body of the Globe. The next discourse shall be

CHAP. II.

Of the Circles, Lines, *&c. described upon the* Superficies *of the* Globe; *beginning with the* Terestrial Globe; *and*

Sect. I. *Of the* Equator.

THe Equator is a great Circle, encompassing the very middle of the Globe between the two Poles thereof, and divides it into two equal parts, the one the North part, and the other the South part. It is (as all great Circles are) divided into 360. equal parts, which are called Degrees. Upon this Circle the Longitude is numbred, from West to East, and from this Circle both waies, viz. North and South the Latitude is reckoned. It is called the Equator, because when the Sun comes to this line (which is twice in one year, to wit, on the tenth of *March*, and the thirteenth

of

of *September*) the Daies and Nights are Equated, and both of one length.

§ II. *Of the* Meridians.

There are infinite of Meridians, for all places lying East or West from one another have ſeveral Meridians; but the Meridians delineated upon the Tereſtrial Globe are in number 36. ſo that between two Meridians is contained ten degrees of the Equator. From the firſt of theſe Meridians (which is divided into twice 90. degrees) accounted from the Equator towards either Pole) is the beginning of Longitude, which upon our Engliſh Globes is at the Ile *Gratioſa*, one of the Iles of the *Azores*, and numbred in the Equator Eaſtwards, with 10, 20, 30, &c. to 360. round about the Globe, till it end where it began.

They are called Meridians, becauſe they divide the Day into two equal parts: for when the Sun comes to the Meridian of any Place, it is then Midday, or full Noon.

§ III. *Of the* Parallels.

As the Meridians are infinite, ſo are the Parallels; and as the Meridian lines delineated upon the Globe are drawn through no more than every tenth degree of the Equator, ſo are the Parallels alſo delineated but upon every tenth degree of the Meridian; leſt the Globe ſhould be too much filled with ſuperfluity of lines, which might obſcure the ſmal names of Places. The Parallel Circles runs Eaſt and Weſt round about the Globe, even as the Equator; only the Equator is a great Circle, and theſe are every one leſs than other, diminiſhing gradually till they end in the Pole. The Parallels are numbred upon the Meridian with 10, 20, 30, &c. to 90. beginning in the Equator, and ending in the Pole.

They are called Parallels; becauſe they are Parallel to the Equator.

§ IIII. *Of the* Ecliptick, Tropicks, *and* Polar Circles.

Theſe Circles though they are delineated upon the Tereſtrial Globe, yet they are moſt proper to the Celeſtial; and therefore when I come to the Celeſtial Globe, I ſhall define them unto you.

§ V. *Of the* Rhumbs.

The Rhumbs are neither Circles nor ſtraight lines, but Heliſpherical or Spiral lines: They proceed from the point where we ſtand, and wind about the Globe till they come to the Pole; where at laſt they looſe themſelves. They repreſent the 32 winds of the Compaſs.

Their uſe is to ſhew the bearing of any two places one from another: that is to ſay, upon what point of the Compaſs any ſhoar or Land lies from another.

There are many of them deſcribed upon the Globe, for the better directing the ey from one ſhoar to the other, when you ſeek after the bearing of any two Lands. Some of them (where there is room for it) have the figure of the *Nautical Card* drawn about the Center or common interſection, and have (as all other Cards have) for the diſtinction of the North point, a *Flowerdeluce* pictured thereon.

They were firſt called Rhumbs by the *Portugals*; and the name ſince uſed by Latine Authors, and continued by all Writers that have occaſion to ſpeak of them.

§ VI. *Of the* Lands, Seas, Ilands, *&c. Deſcribed upon the* Terreſtrial Globe.

The Land deſcribed upon the Globe is bounded with an irregular line, which runs turning and winding into Creeks and Angles, even as the ſhoar which it repreſents (doth.) For the better diſtinction of Lands, &c. this line is cullered cloſe by one ſide thereof with divers Cullers; as with red, yellow, green, &c. theſe cullers diſtinguiſh one part of the Continent from the other; and alſo one Iland from another. That ſide of the line which incompaſſes the Cullers, is the bounds of the Land, the other ſide of the line which is left bare without Cullers, is the limits of the Water.

The *Land* is either *Continents*, or *Ilands*.

A *Continent* is a great quantity of *Land*, not interlaced or ſeparated by the *Sea*, in which many *Kingdomes* and *Principalities* are contained; as *Europe*, *Aſia*, *Africa*, *America*.

An *Iſland* is a part of the *Earth*, environed round with *Waters*; as *Brittain*, *Java*, *S. Laurence Iſle*, *Barmudas*, &c.

Theſe again are ſub-divided into *Peninſula*, *Iſthmus*, *Promonto-*

A *Peninſula* is almoſt an *Iſland*; that is, a track of *Land* which being almoſt encompaſſed round with *Water*, is joyned to the firm *Land*, by ſome little *Iſtmus*; as *Malacca* in the *Eaſt-Indies*, &c.

An *Iſtmus* is a little narrow neck of *Land*, which joyneth any *Peninſula* to the Continent; as the Straits of *Dariene* in *Peru*, and *Corinth* in *Greece*.

A *Promontory* is ſome high Mountain, which ſhooteth it ſelf into the *Sea*, the utmoſt end of which is called a *Cape*, as that great *Cape of good Hope*, and *Cape Verde* in *Africa*.

The *Water* is either *Ocean*, *Sea*, *Straits*, *Creeks*, *Lakes*, or *Rivers*.

The *Ocean* is that generall collection of all *Waters*, which invironeth the whole *Earth* on every ſide.

The *Sea* is a part of the *Ocean*; to which we cannot come but through ſome Strait, as *Mare Mediterraneum*, *Mare Balticum*, and the like.

Theſe take their names either from the adjacent places, as the Britiſh Ocean, the *Atlantick Sea*, &c. or from the firſt diſcoverer, as *Mare Magellanicum*, *Davis* and *Forbiſhers Straits*; &c. Or from ſome remarkable accident, as *Mare Rubrum*, from the red colour of the Sands; *Mare Ægeum*, *Pontus Euxinus*, and the like.

A *Strait* is a part of the Ocean reſtrained within narrow bounds, and opening a way to the Sea; as the *Straits* of *Gibraltar*, *Helleſpont*, &c.

A *Creek*, is a crooked ſhoar, thruſting out as it were two armes to imbrace the Sea, as *Sinus Adriaticus*, *Sinus Perſicus* &c.

A *River* is a ſmall branch of the Sea, flowing into the Land; as *Thames*, *Tiber*, *Rhine*, *Nilus*, &c.

Now that theſe Lands, Ilands, Towns, Seas, Rivers, &c. may at the firſt ſearch be found upon the Globe, all Geographers have placed them thereon according to Longitude, and Latitude.

§ VII. Longitude.

The Longitude is an Arch of the Equator, comprehended between the firſt Meridian and the Meridian of the Place you inquire after. It is numbred on the Equator from the Weſt to the Eaſt-

Eastwards with 10, 20, 30, to 360. degrees, till it end where it began.

§ VIII. Latitude.

The Latitude is an Arch of the Meridian comprehended between the Equator and the place enquired after. It is numbred on the Meridian from the Equator both waies, viz. North and South, till it come to the Poles, or 90 degrees.

Thus much may serve for the description of the Terrestrial Globe: I therefore come to treat of the Cœlestial.

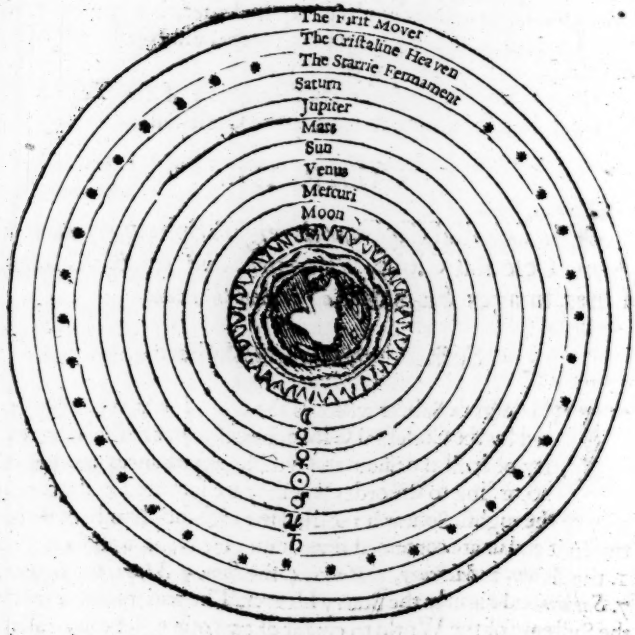
CHAP. III.

Of the Celestial Globe, *or the eighth* Sphere, *represented by the* Celestial Globe: *its motion, and of the* Circles, Lines, Images, Stars, &c. *described thereon.*

Sect. I. *Of the eighth* Sphere.

THe eighth Sphear which is the starry Heaven, is represented by the Cœlestial Globe, because upon the Convexity of it all the Stars and visible appearances are placed according to the order that they are scituated in the concavity of the eighth Sphear. It is called the eighth Sphear because between it and us are contained seven other Heavens, or Sphears; as 1. the *Moon*, 2. *Mercury*, 3. *Venus*, 4. the *Sun*, 5. *Mars*, 6. *Jupiter*, 7. *Saturn*, and eightly the Starry Heaven. The antients have made the Systeme of the World to consist of two other Sphears, called the *Christalline Heaven*, and the *Primum Mobile*, or first Mover: as in the following figure is represented.

A figure wherein may be ſeen the Compoſition of the whole frame of the World.



§ II. *Of the Motion of the eighth* Sphear.

There hath been attributed to the eighth Sphear a twofold motion; the one called its Diurnal Motion, which is made from Eaſt to Weſt, upon the Poles and Axis of the World, and the other called its Second motion; which is made from Weſt to Eaſt upon the Poles and Axis of the Ecliptick.

The Diurnal Motion is cauſed by the violent Motion of the

Primum

Primum Mobile; for in 24 hours it carries along with it, not only the eighth Heaven or Orb of fixed Stars, but the Orbs of the *Sun*, the *Moon* and all the rest of the Planets. It is called the *Diurna Motion*, because it is finished in one Day.

The second Motion is unproperly attributed to the eighth Sphear; it being indeed the Motion of the Equinoctial, though Authors sometimes carelesly mention the one instead of the other. Therefore in the next Section, where I treat of the Equinoctial, I shall at large explain unto you the nature of this mis-called *Second Motion*.

§ III. *of the* Equinoctial.

The Equinoctial on the Cœlestial Globe, is the same line formerly called the Equator upon the Terrestrial; only with this difference, that the Equator remains fixt upon the Terrestrial Globe, but the Equinoctial upon the Cœlestial Globe is moveable; (or at least must be imagined to move) contrary to the *Diurnal motion* from West to East, upon the Poles of the Ecliptick: I say imagined to move, because in the Heavens it doth really move, though on a material Globe it would be inconvenient to make a moveable Equinoctial, and therefore it hath one fixed: which for this and the next age will sufficiently serve, without much deviation from the truth it self.

Now that the difference between the Equator upon the Terrestrial Globe, and the Equinoctial upon the Cœlestial, may be proved; and the motion of the Equinoctial be the better understood; I shall only bring this example;

All places that were formerly under the Equator, do and will keep the same Longitude, and remain still under the Equator: as may be proved by comparing the Ancient and modern *Geographers* together: but those Stars that were formerly under the Equinoctial, do not keep the same Longitude, nor remain under the Equinoctial: because the Equinoctial (as aforesaid) hath a motion from West to East, upon the Poles of the Ecliptick. But the Stars being fixed in their one Sphear, like knots in wood, and therefore move not, are by the precession of the Equinox left behind the Equinoctial Colure, and so are caused to alter their Longitude; as by comparing the Observations of ancient and modern Astronomers together, it will appear; for about 346

years before Christ, the first Star in the *Rams horn* was by the *Egyptian* and *Grecian* Astronomers observed to be in the Equinoctial Colure: and 59 years ago, when *Tycho* observed, it was found to be in 27 degrees 37 minutes of ♈. So that in about 2000 years it is moved forwards 28 degrees, and will according to *Tycho's* opinion, finish its Revolution in 25412 years: According to which motion, I have Calculated this following Table, for finding the Degrees and Minutes of the Equinoctial motion, answerable to any number of years within the said Revolution.

ys	deg.	m	years	deg	m
1	0	0 3/4	100	1	25
2	0	1 1/2	200	2	50
3	0	2 1/2	300	4	15
4	0	3 1/3	400	5	40
5	0	4 1/4	500	7	5
6	0	5	1000	14	10
7	0	5 3/4	2000	28	20
8	0	6 1/2	3000	42	30
9	0	7 1/4	4000	56	40
10	0	8 1/2	5000	70	50
20	0	17	10000	141	40
40	0	34	20000	283	20
60	0	51	25000	354	10
80	1	8	25412	360	

This Table may be of use for finding the Equinoctial position of any Star, for any year either past, present, or to come. Its use is very easie: For if you desire to know the motion of the Equinox for any number of years, you need but seek your number in the Collumn of years, and against it you have the degrees and minutes of the Equinoctial motion.

But though the Stars have this motion one way, viz. in Longitude, yet do they not at all alter their Latitudes, because the motion of the Equinoctial is made upon the Poles of the Ecliptique.

§ IIII.

§ IIII. *Of the* Ecliptique.

The Ecliptique is a great Circle, lying oblique or aſlope from the Equinoctial, making an Angle of 23½ degrees with it: It cuts the Equinoctial into two equal parts, and is cut by the Equinoctial in two oppoſite points, viz. in ♈, and ♎. It divides the Globe into two equal parts, called *Hemiſphears*; the one the Northern, and the other the Southern *Hemiſphear*. It is divided into 12 equal Parts, which are called the twelve *Signes*, every part being noted with the Character of the Signe belonging unto it, as unto *Aries*, ♈, to *Taurus*, ♉, to *Gemini*, ♊, and ſo of the reſt. From every one of theſe 12 diviſions proceed both waies, viz. North, and South, Circles of Longitude, into the Poles of the Ecliptique. Each of theſe twelve Signes is divided into 30 equal parts, which are called degrees; and are numbred upon every tenth degree with 10, 20, to 30. and upon my new Cœleſtial Globe for more preciſeneſs, every degree is again divided into halfs.

„ It is called the Ecliptique as being derived from the Greek „ word; *Ekleipſin*, which ſignifies to want light, becauſe in and „ about it happen all the defects and Eclipſes both of the Sun and „ the Moon.

„ It is alſo called the way of the Sun, becauſe the Sun goes al- „ waies under it, paſſing through it in all his Annual Courſe.

§ V. *Of the* Poles *of the* Ecliptick.

There are two Poles of the Ecliptick, the one the North Pole, the other the South Pole; and are called North or South according to their poſition next the North or South Pole of the World. Each is diſtant from its correſpondent Pole of the World 23 degrees 30 minutes.

As on the Terreſtrial Globe all the Meridians deſcribed thereon meet in the Pole of the World, ſo on the Cœleſtial all the Circles of Longitude drawn through the twelve Signes meet in the Poles of the Ecliptick.

§ VI. *Of the* Axis *of the* Ecliptick.

Through the Poles of the Ecliptick is imagined to paſs a ſtraight line through the Center of the Plain of the Ecliptick; which is called the Axis of the Ecliptick, upon which the ſecond motion of the Ecliptick is performed: even as the diurnal motion is performed upon the Axis of the World.

§ VII. *Of the* Colures, *and* Cardinal Points.

There are two great Circles cutting one another at right angles in the Poles of the World, which are called the *Colures*. Each *Colure* recives an additional name from the point in the Ecliptick that it cuts; as the one paſſes from Pole to Pole through the beginning of ♈ and ♎ which being two Equinoctial Signes, names therefore that Colure the Equinoctial Colure: The other paſſes through the beginning of ♋ and ♑, which are Solſticial Signes, and therefore names that the Solſticial Colure.

Theſe Colures by interſecting one another, divide themſelves into four Semi-circles; and theſe Semi circles divide the Ecliptick into four equal parts. viz. ♈, ♋, ♎, and ♑.

The point of the Ecliptick that theſe interſections paſs through are called the four Cardinal points, and are of great uſe in Aſtronomy; for according to the Suns approach to any of them the Seaſon of the Year is altered into *Spring*, *Summer*, *Autumn*, *Winter*: as ſhall be ſhewed hereafter.

§ VIII. *Of the* Tropicks.

There are two ſmaller Circles Parallel to the Equinoctial, which are called the *Tropicks*, the one called the *Tropick* of *Cancer*, the other the *Tropick* of *Capricorn*: they are diſtant from the Equinoctial 23. degrees 30. minutes; and therefore are the bounds of the Ecliptick. They receive their names from the Coeleſtial Signe that they are joyned unto; as the one the *Tropick* of *Cancer*, becauſe it touches the Signe of *Cancer*, the other the *Tropick* of *Capricorn*, becauſe it touches the Signe of *Capricorn*.

§ XI.

IX. *Of the Circles* Arctick *and* Antarctick.

About the Poles of the World are deſcribed two ſmal parallel Circles; the one called the *Arctick*, the other the *Antarctick*: That in the North is called the *Arctick Circle*, that in the South the *Antarctick Circle*.

They have the ſame diſtance from the Poles of the World that the *Tropicks* have from the Equinoctial Circle, (*viz.* 23 degrees 30 minutes) and that the *Ecliptick* hath from the Poles of the World; and therefore run through the Poles of the *Ecliptick*.

X. *Of the* Images *called* Conſtellations, *drawn upon the Celeſtial Globe.*

Here I think fit to be beholden to Dr. *Hood*, for the paines he hath taken in his Comment on the *Images* and *Conſtellations*. He ſaith, The Stars are brought into Conſtellations for inſtructions ſake: things cannot be taught without names, to give a name to every Star had been troubleſome to the Maſter, and for the Scholler; for the Maſter to deviſe, and for the Scholler to remember: and therefore the Aſtronomers have reduced many Stars into one Conſtellation, that thereby they tell the better where to ſeek them, and being ſought how to expreſs them.

All the Conſtellations formerly notified by the Antients were in number 48. twelve whereof we call the twelve Signes of the Zodiack, *viz.* 1. *Aries*, ♈. 2. *Taurus*, ♉. 3. *Gemini*, ♊. 4. *Cancer*, ♋. 5. *Leo*, ♌. 6. *Virgo*, ♍. 7. *Libra*, ♎. 8. *Scorpio*, ♏. 9. *Sagittarius*, ♐. 10. *Capricorn*, ♑. 11. *Aquarius*, ♒. 12. *Piſces*, ♓. One and twenty more are placed in the North Hemiſphere, and are called 1 *Urſa minor*, 2 *Urſa major*, 3 *Draco*, 4 *Cepheus*, 5 *Bootes*, 6 *Corona Septentri*, 7 *Hercules*, 8 *Lyra*, 9 *Cygnus*, 10 *Caſſiopea*, 11 *Perſeus*, 12 *Auriga*, 13 *Serpentarius*, 14 *Serpens Ophiuchi*, 15 *Sagitta*, 16 *Aquila*, 17 *Delphinus*, 18 *Equiculus*, 19 *Pegaſus*, 20 *Andromeda*, 21 *Triangulum*. The other 15 are ſeituate in the South Hemiſphere, and called 1 *Cetus*, 2 *Orion*, 3 *Eridanus*, 4 *Lepus*, 5 *Canis major*, 6 *Canicula*, 7 *Argo Navis*, 8 *Hydra*, 9 *Crater*, 10 *Corvus*, 11 *Centaurus*, 12 *Lupus*, 13 *Ara*, 14 *Corona Auſtrina*, 15 *Piſces Auſtrina*. Beſides there are two other Conſtellations in the North Hemiſphere, *viz.* *Antinous*,

and *Coma Berenices*: which becauſe they were not ſpecified by the Ancients are here inſerted apart.

Now the Aſtronomers did bring them into theſe figures, and not into other, being moved thereto by theſe three reaſons: firſt theſe Figures expreſs ſome properties of the ſtars that are in them; as thoſe of the *Ram* to be hot and dry; *Andromeda* chained betokeneth impriſonment: the head of *Meduſa* cut off, ſignifieth the loſs of that part: *Orion* with his terrible and threatning geſture, importeth tempeſt, and terrible effects: The *Serpent* the *Scorpion* and the *Dragon* ſignifie poyſon: The *Bull*, inſinuateth a melancholy paſſion: The *Bear* inferreth cruelty, &c. Secondly, the ſtars, (if not preciſely yet after a ſort) do repreſent ſuch a figure, and therefore that Figure was aſſigned them: as for example, the *Crown*, both North and South; the *Scorpion* and the *Triangle*, repreſent the figures which they have. The third cauſe was the continuance of the memorie of ſome notable men, who either in regard of their ſingular paines taken in Aſtronomy, or in regard of ſome other notable deed, had well deſerved of man-kind.

The firſt Author of every particular Conſtellation is uncertain; yet are they of great antiquity; we receive them from *Ptolomie*, and he followed the *Platonicks*, ſo that their antiquity is great. Moreover we may perceive them to be ancient by the Scriptures, and by the Poets. In the 38 Chapter of *Job* there is mention made of the *Pleiades*, *Orion*, and *Arcturus*, and *Mazzaroth*, which ſome interpret the 12 Signes: *Job* lived in the time of *Abraham*, as *Syderocrates* maketh mention in his Book *de Commenſurandis locorum diſtantiis*.

Now beſides all this, touching the reaſon of the invention of theſe conſtellations the Poets had this purpoſe, *viz.* to make men fall in love with Aſtronomy: And to that intent have to every Conſtellation invented ſtrange conceited ſtories (as you may read at the latter end of this Book) therin imitating *Demoſthenes*, who when he could not get the people of *Athens* to hear him in a matter of great moment, and profitable for the Common-wealth, he began to tell them a tale of a fellow that ſold an Aſs; by which tale, he ſo brought on the Athenians that they were both willng to hear his whole Oration, and to put in practice what he exhorted them to. The like intent had the Poets inventing of thoſe Stories: They ſaw that Aſtronomy being for com-

commodity ſingular in the life of man, was almoſt of all men utterly neglected: Hereupon they began to ſet forth that Art under Fictions; that thereby, ſuch as could not be perſwaded by commodity, might by the pleaſure be induced to take a view of theſe matters: and thereby at length fall in love with them. For commonly you ſhall note this, that he that is ready to read the Stories, cannot content himſelf therewith, but deſireth alſo to know the Conſtellation, or at leaſt-wiſe ſome principal Star therein.

There are in Heaven yet twelve Conſtellations more, poſited about the South Pole, which were added by *Frederico Houtmanno*, inhabiting on the Iſland *Sumatra*; who being accommodated with the Inſtruments of that immortal *Tycho*, hath obſerved the Longitude and Latitude of thoſe Stars, reduced them into Conſtellations, and named them as follows, 1 The *Crane*, 2 The *Phenix*, 3 The *Indian*, 4 The *Peacock*, 5 The *Bird of Paradice*, 6 The *Fly*, 7 The *Camelion*, 8 The *South Triangle*, 9 The *Flying Fiſh*, 10 *Dorado*, 11 The *Indian Fowl*, 12 The *Southern Serpent*.

XI. *Of the Number of the Stars.*

Although in Heaven there be a very great number of viſible Stars, which for their multitude ſeem innumerable; yet no wiſe man will from thence infer that they are impoſſible to be counted: for there is no Star in Heaven that may be ſeen, but its Longitude and Latitude may with meet Inſtruments for that purpoſe be exactly found, and being once found, it may have a name allotted it, which with its Longitude and Latitude may be Catalogized either for the memory of the Obſerver, or the knowledge of Poſterity. Now therefore if any one Star may be obſerved, they may all be obſerved; and then may they all have Names given them; which though to the ignorant it ſeem uncredible, yet to the ſons of God, (as *Joſephus* cals Aſtronomers) who herein participate of their fathers knowledge, it is eaſie to *number the Stars, and call them all by their Names Pſal.* 97. 4.

But though all the Stars in Heaven may be numbred and named, yet hath not *Tycho* or the Ancient Aſtronomers thought fit to take notice of more then 1241. of the chiefeſt that are viſible in our Horizon, they being ſufficient for any purpoſe that we ſhall have occaſion to apply them unto. Yet of late the induſtry of *Fred. Houtman*

man aforeſaid hath added to the Catalogue 136 Stars, with their Longitude Latitude and Magnitude, and given Names unto them: which upon my new Globes I have alſo aſcerted, as may be ſeen about the South Pole thereof. So that with theſe 1241 obſerved by *Tycho* and the Antients, and theſe 136, the whole number of the Catalogue is 1377.

Some other Stars of late have been alſo obſerved by *Baierus*, among the ſeveral Conſtellations aforeſaid; but not of any conſiderable Magnitude: and therefore I think fit to paſs them by, and come to their ſcituation in Heaven, according to Longitude and Latitude.

XII. *Of the Scituation of the* Stars.

Longitude of the Stars.

The Stars are ſcituate in Heaven according to their Longitude and Latitude. As the Longitude of any place on the Terreſtrial Globe is an Arch of the Equator comprehended between the firſt Meridian and the Place; ſo the Longitude of any Star on the Celeſtial Globe is an Arch of the Ecliptick contained between the firſt point of *Aries* and the Star inquired after. But yet becauſe the Ecliptick is divided into twelve Signes, the Longitude of a Star is therefore (in the moſt cuſtomary account) an Arch of the Ecliptick comprehended between the Semi-circle of Longitude paſſing through the beginning of the Signe the Star is in, and the Semi-circle of Longitude paſſing through the center of the Star.

Latitude of the Stars.

The Latitude of a Star is either North or South: North if on the North ſide of the Ecliptick, South if on the South ſide of the Ecliptick. As the Latitude of any Place on the Terreſtrial Globe is an Arch of the Meridian contained between the Equator and the Parallel of the Place, So is the Latitude of any Star on the Celeſtial Globe an Arch of a Semi-circle of Longitude comprehended between the Ecliptick and the Star inquired after.

XIII. *Of the* Magnitudes *of the* Stars.

For the better diſtinction of the ſeveral ſizes of Stars, they are divided into ſix ſeveral Magnitudes. The biggeſt and brighteſt Stars are called Stars of the firſt Magnitude: Thoſe one ſize inferiour

inferiour in light and bigneſs are called Stars of the Second Magnitude, Thoſe again one ſize inferiour to the Stars of the Second Magnitude, are called Stars of the Third Magnitude, and ſo the Stars gradually decreaſe unto the ſixth Magnitude, which is the ſmaleſt, ſome few obſcure Stars only excepted, which for their minority and dimneſs are called *Nebula*. Theſe ſeveral Magnitudes of the Stars are expreſſed on the Globe in ſeveral ſhapes: as may be ſeen in a ſmal Table placed on the Globe for that purpoſe.

Now for your further ſatisfaction and delight, I have inſerted a Collection of D. *Hoods*, wherein is expreſſed the meaſure of every Magnitude, and the proportion it hath, firſt, to the Diameter, and ſecondly to the Body of the Earth. The meaſures of the ſeveral Stars.

The greatneſs of any thing (ſaith he) cannot be better expreſſed than by comparing it to ſome common meaſure, whoſe quantity is known: the common meaſure whereby Aſtronomers expreſs the greatneſs of the Stars is the Earth;

Sometimes they compare them with the Diameter of the Earth, ſometimes with the Globe thereof: The Diameter according to their account which allow but 60 miles to a Degree, containeth 6822 $\frac{8}{11}$ miles; and the whole ſolidity of the Globe contains 165,042,481,283. miles and $\frac{29}{187}$. According to *Ptolomie*, who allotteth to every Degree 62 $\frac{1}{2}$ miles: the Diameter containeth 7159 miles $\frac{1}{11}$, and the whole ſolidity of the Globe hath 192, 197, 184,917, $\frac{473}{3311}$ miles.

The proportion of the Diameters of the fixed Stars, compared with the Diameter of the Earth.

The Diameter of a fixed Star of the firſt Magnitude compared with the Diameter of the Earth hath ſuch proportion to it as 19 hath to 4: therefore it containeth the Diameter of the Earth 4 times and $\frac{3}{4}$.

The Diameter of a Star of the ſecond Magnitude is unto the Diameter of the Earth as 269 is to 60: therefore it containeth it 4 $\frac{29}{60}$ times.

The Diameter of a fixed Star of the third Magnitude is unto the Diameter of the Earth as 25 unto 6: therefore it containeth it 4 $\frac{1}{6}$ times.

The Diameter of a fixed Star of the fourth Magnitude is unto

the Diameter of the Earth as 19 unto 5: therefore it containeth it 3 4/5 times.

The Diam. of a fixed Star of the fifth Mag. is unto the Diam. of the Earth, as 119 unto 36, therefore it containeth it 3 11/36 times.

The Diam. of a fixed Star of the ſixth Mag. is unto the Diam. of the Earth, as 21 unto 8; therefore it containeth it 2 5/8 times.

As for the proportions of the cloudy and obſcure Stars, they are not expreſſed; becauſe they are but few, and of no great account in reſpect of their ſmalneſs.

The proportions of the fixed Stars compared with the Globe of the Earth, are as follow.

A Star of the firſt Magnitude is to the Globe of the Earth, as 6859, to 64. therefore it containeth the Globe of the Earth 107 1/64 times.

A Star of the ſecond Magnitude is to the Globe of the Earth, as 19465109 is to 216000. therefore it containeth it 90 1/8 times.

A Star of the third Magnitude is to the Globe of the Earth, as 15625 is unto 216: therefore it containeth it 72 1/3 times.

A Star of the fourth Magnitude is to the Globe of the Earth as 6850 is unto 125: therefore it containeth the Globe of the Earth 54 11/12 times.

A Star of the fifth Magnitude is to the Globe of the Earth, as 1685159 is unto 46656: therefore it containeth the Globe of the Earth 36 1/8 times.

A Star of the ſixth Magnitude is to the Globe of the Earth, as 9261 is unto 512: therefore it containeth the Globe of the Earth 18 1/10 times.

I confeſs all this may ſeem matter of incredulity to thoſe whoſe underſtanding is ſwayed by their viſual ſence; but if they be capable to conſider the vaſt diſtance of thoſe Huge Bodies, (the Stars) from the face of the Earth, and alſo the diminutive quality of Diſtance, their reaſon will be rectified, and their incredulity turn'd into an acknowledgement of the unſpeakable wiſdom of Almighty God; and they will ſay with the *Pſalmiſt. Great is our Lord, Great is his Power, his wiſdom is infinite. Pſal.* 147. 5.

The diſtance of the Stars therfore from the Earth, is according to Mr. *John Dee's* Computation, 20081 1/2 Semidiameters of the Earth. The Semidiameter of the Earth containeth of our com-

common miles 3436 $\frac{4}{11}$. Such miles as the whole Earth and Sea round about is 21600: allowing for every degree of the greatest Circle 60 miles: so that the distance of the Stars from the Earth, is in miles 69006540. Now as Mr. *Dee* saith, (almost in the same words) if you weigh well with your selfe this little parcel of fruit Astronomical; as concerning the bigness and distance of the Stars, &c. and the Huge massines of the Starry Heaven, you will find your Consciences moved with the Kingly Prophet to sing the confession of Gods Glory; and say, *The Heavens Declare the Glory of God, and the firmament sheweth forth the works of his Hands.*

XIIII. *Of the* Nature *of the* Stars.

To many of the Principal Stars there is in Planetical Characters prefixed there Planetical Natures. The Astrologers make greate use of them for knowing the nature of the Stars: for those Stars that have the character of ♄ adjoyned are said to be of the nature of ♄: those that have ♃ adjoyned, are of the nature of ♃: and so of the rest. If a Star have the characters of two Planets adjoyned, that Star participates of both their Nautes, but most of that Planets whose character is first placed.

The use Astronomers make of those characters, is for knowing the couller of any Stars; as if a Star have ♄ adjoyned, it is of the couller of ♄; if ♃, it is the couller of ♃, &c.

The fixed Stars are known from the Planets by their continual twinckling; for the Planets never twinckle, but the fixed Stars do.

XV. *Of Via Lactea, or the* Milky way.

This subject because it is already so fully handled by Dr. *Hood*, that more then he hath written cannot well be said, either of his owne opinion or other mens, I thinke fit therefore to give you his own words: which are as follow.

VIA LACTEA. or *Circulus Lacteus* by the Latines so called; and by the Greekes, *Galaxia*, and by the English the *Milky way*. It is a broad white Circle that is seen in the Heaven: In the North Hemisphere, it beginneth at *Cancer*, on each side the head thereof, and passeth by *Auriga*, by *Perseus*, and

and *Caſſiopeia*, the *Swan*, and the head of *Capricorn*, the taile of *Scorpio*, and the feet of *Centaur*, *Argo* the *Ship*, and ſo unto the head of *Cancer*. Some in a ſporting manner, do call it *Watling ſtreet*; but why they call it ſo, I cannot tell; except it be in regard of the narrowneſs that it ſeemeth to have, or elſe in reſpect of that great High way that lieth between *Dover* and S. *Albons*, which is called by our men *Watlin ſtreet*.

Concerning this Circle there are ſundry opinions: for there is great difference among ſome writers, both touching the place, matter and efficient cauſe thereof. *Ariſtotle* diſſenteth from all other, both Philoſophers and Poets, in the place, matter, and cauſe of this Circle; ſaying, that it is a Meteor ingendered in the Air, made of the vapors of the earth, drawn up thither by the heat of the Sun, and there ſet on fire. But his opinion is of all men confuted.

Firſt, touching the place, it cannot be in the Air; for whatſoever is in the Air, is not ſeen of all men, at all times, to be under one and the ſame part of Heaven. If we ſee it in the South, they that are in the Weſt ſhall ſee it under the Eaſt ſide of the Heaven; and they that are in the Eaſt, ſhall ſee it in the Weſt part of the Heaven; but this Circle is of all men ſeen alwaies under the ſame part of Heaven, and to be joyned with the ſame Stars; therefore it cannot be in the Air.

Againe, for the matter, it cannot be made of that which *Ariſtotle* nameth (*i. e.*) the vapours of the earth, becauſe of the long continuance of the thing, and that without any alteration: for it is impoſſible that any Meteor made of vapours drawn up from the water, or exhalations from the earth, ſhould laſt ſo long; as may be ſeen in blazing Stars; which though they have continued long, as namely, 16. moneths, ſome more, ſome leſs; yet at the length they have vaniſhed away: whereas this Circle hath continued from the beginning unto this day. Beſides, put caſe it were made of theſe exhalations; Whence will they infer the uniformity thereof? The Comets do alter diverſly, both in the faſhion of their blazing, and alſo in their ſeveral quantities; whereas in this Circle, there is nothing but the ſame part, alwaies of one form and of one bigneſs. In the efficient cauſe thereof he muſt needs err: for if it be neither in the Air, nor made of the exhalations of the earth, it cannot be cauſed by the Sun; for the

one

one is the place, and the other the matter, wherein, and whereupon the Sun ſheweth his power.

All other (beſides *Ariſtotle*) agree in the place, but differ in the efficient cauſe thereof: and they are either Philoſophers, or Poets. Both theſe affirm that it is in the Firmament (*i. e.*) in the eight Sphear; but they diſagree in the cauſe thereof.

The Philoſophers (and chiefely *Democritus*) affirm the cauſe of the thing, to be the exceeding great number of Stars in that part of Heaven, whoſe beams meeting together ſo confuſedly, and not coming diſtinctly to the ey, cauſeth us to imagine ſuch a whiteneſs as is ſeen. But the beſt opinion is this, that this *Milky way* is a part of the Firmament, neither ſo thin as the other parts thereof are, nor yet ſo thick as the Stars themſelves. If it were as thin as the other parts of the Heaven beſides the Stars, then could it not retain the light, but the light would paſs through it and not be ſeen: If it were as thick as the Stars, then would the light be ſo doubled in it, that it would gliſter and ſhine, as the Stars themſelves do: but being neither ſo thin as the one, nor ſo thick as the other, it becommeth of that whiteneſſe we ſee. Thus far D *Hood*. But

Our modern Philoſophers conceive this *Lactean* whiteneſs ariſeth from a great number of little Stars, conſtipated in that part of Heaven; flying ſo ſwiftly from the ſight of our eyes, that we can perceive nothing but a confuſed light: this the *Telleſcope* (more lately found out) doth evidently demonſtrate to us: by the benefit of which, little Stars (otherwiſe inconſpicuous to our eyes) are there clearly diſcerned.

About the Southern Pole are ſeen two white ſpots, like little clouds, coloured like the *via Lactea*. One of which is trebble the Latitude of the other; ſome Mariners call them *Nubeculæ Magellani*.

This *Milkie way* is deſcribed on the Globe between two tracks of ſmal pricks running through the Images mentioned in the beginning of this Section.

Thus have you the definition of the Globes; with the deſcription of all the Lines, Circles, &c. deſcribed thereon. I ſhall now explain unto you the meaning of ſeveral words of Art, which in the uſe of them you will meet with, and then come to the uſe it ſelf.

And firſt, what is meant by the word *Horizon*.

XVI.

When I ſpake of the Horizon before, I only mentioned the wooden Horizon or frame about the Globe; which becauſe it repreſents the Mathematical Horizon, is therefore called the Horizon: but the word *Horizon* is to be conſidered more particularly two manner of waies: as

Firſt the *Natural Horizon*,

Secondly, the *Mathematical Horizon*.

The Natural Horizon is that apparent circle which divides the viſible part of Heaven from the inviſible; it extends it ſelf in a ſtraight line from the ſuperficies of the Earth, every way round about the place you ſtand upon, even into the very circumference of the Heavens. It is only diſcerned at Sea, or on plain ground, that is free from all hinderance of the ſight, as Hills, Trees, Houſes, &c.

The Mathematical Horizon (which indeed is meant in this Treatiſe, ſo oft as I ſhall have occaſion to name the word Horizon) is a great circle which divides that part of Heaven which is above us, from that which is under us, preciſely into two equal parts: whoſe Poles are the Zenith and Nadir. In this circle the Azimuths or Vertical circles are numbred: and by this circle our daies and nights are meaſured out unto us: for while the Sun is above the Horizon it is day; and when it is under the Horizon it night.

This circle is repreſented unto us by the upper plain of the wooden Horizon: Therefore ſo oft as you are directed to bring any degree or Star &c. to the Horizon, it muſt be underſtood that you muſt turn the Globe till the degree or Star come juſt to the upper inner edge of the wooden Horizon.

Zenith. The *Zenith*, and *Nadir*, are two points oppoſite to one another, The Zenith is that point in Heaven directly over our heads:

Nadir. and the Nadir is that point in Heaven directly under our feet.

Azimuths or *Vertical Circles* The *Azimuths* or *Vertical circles* are great circles paſſing through the Zenith and Nadir, whoſe Poles are the Zenith and Nadir. And as the Meridians cut the Equator and all Parallels to the Equator at right angles, ſo the Azimuths cut the Horizon and all Almicanthars at right angles alſo. The Azimuths (as the Meridians) are infinite; and are numbred by degrees from the Eaſt and Weſt points towards the North and South in the Horizon: as alſo is the Amplitude.

The

The *Almicanthars* are circles parallel to the Horizon, whoſe Poles are the Zenith and Nadir. They are alſo called *Circles of Altitude*, becauſe when the Sun Moon or any Star is in any number of degrees above the Horizon, it is ſaid to have ſo many degrees of Altitude; which degrees of Altitude are numbred on the Vertical circle from the Horizon upwards, towards the Zenith. The Almicanthars are alſo infinite, as Parallels, Meridians and Azimuths are. *Almicanthars, or Circles of Altitude.*

The *Amplitude* is the number of degrees contained between the true Eaſt or Weſt point in the Horizon, and the riſing or ſetting of the Sun Moon or Stars. &c. *Amplitude.*

The *Declination* is the number of degrees that the Sun Moon or any Star is diſtant from the Equinoctial towards either Pole: and hath a double denomination, viz. *North Declination*; and *South Declination*: for if the Sun Moon or Star ſwarve towards the North Pole they are ſaid to have North Declination; if towards the South Pole South Declination. *Declination.*

The *Right Aſſenſion* is the number of degrees of the Equinoctial (accounted from the firſt point of *Aries*) which comes to the Meridian with the Sun Moon or Star, or any other point in Heaven propoſed. *Right Aſcenſion.*

The *Oblique Aſſenſion* is the number of degrees of the Equinoctial which comes to the Eaſt ſide the Horizon with the Sun Moon or any Star. *Oblique Aſcenſion.*

The *Oblique Deſcenſion* is the degrees of the Equinoctial which comes to the Weſt ſide the Horizon with the Sun Moon or any Star. *Oblique Deſcenſion.*

The *Aſcenſional difference* is the number of degrees after ſubſtraction of the Oblique Aſſenſion from the Right Aſſenſion. *Aſcenſional Difference.*

So many degrees as you ſail towards the Pole, you are ſaid to *Raiſe the Pole*, and ſo many degrees as you ſail from the Pole, you are ſaid to *Depreſſe the Pole*. *Raiſe the Pole. Depreſs the Pole.*

Courſe is the point of the Compaſs you ſail upon; as if you ſail Eaſtwards, it is an Eaſterly Courſe, if Weſt a Weſterly Courſe. &c. *Courſe.*

Diſtance is the number of Leagues you have ſailed from any Place, upon any Courſe. *Diſtance.*

A *Zone* is a ſpace of the Earth contained between two Parallels. The ancient Geographers made five Zones in the Earth; two Frozen, two Temperate, and one Burnt Zone. *Zone.*

Frozen Zone. The two *Frozen Zones* are thoſe parts of the Globe comprehended between the North Pole and the Arctick Circle, and the South Pole and the Antarctick Circle; by the Antients called *Inhabitable*, becauſe the Sun being alwaies far remote from them ſhoots its beams obliquely upon them, which oblique beams are ſo very weak, that all their Summer is but a continued Winter, and the Winter (as they thought) impoſſible to be at all indured.

Temperate Zone. The *Temperate Zones* are the ſpace of Earth contained between the Arctick Circle and the Tropick of ♋, and the Antarctick Circle and the Tropick of ♑: by the Antients called *Temperate* and *Habitable*, becauſe they are compoſed of a ſweet mediocrity, between outragious Heat and extreamity of Cold.

Burnt Zone. The *Burnt Zone* is the ſpace of Earth contained between the Tropick of ♋, and the Tropick of ♑, called by the Antients *Unhabitable*, becauſe in regard the Sun never moves out of this Zone but darts its beams perpendicularly upon it, they imagined the Air was ſo unſufferable hot, that it was impoſſible for any to inhabite in this Zone. So that as you ſee they held the two Temperate Zones only habitable; and the two Frozen Zones and one Burnt Zone altogether impoſſible to be inhabited. But their Succeſſors either animated by induſtry or compeld by neceſſity, have apparently refuted their Aſſertion; for at this time many thouſands can witneſs that their bloods are not ſo greaſie as to melt in the ſcortching heat of the one, or ſo watry as to congeal in the Icy froſts of the other.

Climates. The Antients have yet otherwiſe divided the Earth into four and twenty *Northern Climates*, and four and twenty *Southern Climates*: ſo that in all there is eight and forty Climates. The Climates are altered according to the half hourly increaſing of the longeſt daies; for in the Latitude where the longeſt daies are increaſed half an hour longer than they are at the Equator (*viz.* longer than 12 hours) the firſt Climate begins; and in the Latitude where they are increaſed an whole hour longer than in the Equator, the ſecond Climate begins; where the daies are increaſed three half hours longer than in the Equator, the third Climate begins; and ſo onwards, the Climates alter according as the longeſt day increaſes half an hour, till you come to find the longeſt day 24 hours long.

Now the Antients (in thoſe times knowing no more than nine Habitable Climates, gave names only to nine. The firſt they

they called *Dia Meros*, after the name of a famous Inland Iland, which is ſcituate about the middle of that Climate, and is now called *Gueguere*. The ſecond Climate they called *Dia Syenes*, after the name of an eminent Citty in *Egypt*, lying about the midſt of that Climate. The third *Dia Alexanderas*, after the name of the Metropolitan Citty of *Egypt*. The fourth *Dia Rhodes*. The fifth *Dia Romes*. The ſixth *Dia Ponton*. The ſeventh *Dia Boriſthenos*, The eighth *Dia Ritheos*. The ninth *Dia Daniam*.

Theſe names belong only to the Climates on the North ſide of the Equator. But thoſe on the South ſide (in regard of the ſmal Diſcoveries thoſe Ages had on that ſide the Equator) were diſtinguiſht only by the addition of the word *Anti*, to the ſame Southerly Climate: as the firſt Southern Climate (which is that Climate that lies as many degrees to the South-ward as the firſt doth to the North-ward) they called *Anti Meroes*. The ſecond *Anti Syenes*. The third *Anti Alexanderas*: and ſo on to the ninth.

In every Climate is included two Parallels, which are of the ſame nature with the Climates, ſave only that as the Climates alter by the half hourly increaſing of the longeſt day, the parallels alter by the quarter hourly increaſing of the longeſt day. *Parallels.*

Furthermore, in reſpect of the Horizon, we find the Sphear conſtituted into a threefold Poſition: as firſt into a *Direct Sphear*, Secondly a *Parallel Sphear*, Thirdly an *Oblique Sphear*.

A *Direct Sphear* hath both the Poles of the world in the Horizon, and the Equinoctial tranſiting the Zenith. In a Direct Sphere all the circles parallel to the Equator make right angles with the Horizon, and are alſo divided into two equal parts by the Horizon: and in a Direct Sphere the Sun Moon and Stars are alwaies twelve hours above the Horizon, and twelve hours under the Horizon, and conſequently make twelve hours Day, and twelve hours Night. *Direct Sphear*

It is called a *Direct Sphear* becauſe all the Celeſtial Bodies as Sun Moon and Stars &c. By the Diurnal motion of the Primum Mobile, aſcend directly above and deſcend directly below the Horizon.

They that inhabite under the Equator have the Sphere thus poſited; as in the Iland *Borneo*, *Sumatra*, *Celebes*, *St. Thomas*, a great part of *Africk*, *Peru* in the *Weſt-Indies*: &c. as you may

ſee by the *Globe* it ſelf; if you move the *Braſen Meridian* through the notch in the *Horizon*, tell the Poles thereof touch the *Horizon*. As in the Figure.

Parallel Sphere A *Parallel Sphear* hath one Pole of the world in the Zenith, the other in the Nadir, and the Eqninoctial line in the Horizon.

In a *Parallel Sphear* all the Circles Parallel to the Equinoctial are alſo Parallel to the Horizon, and in a Parallel Sphear from the 10th of *March* to the 13th of *September* (the Sun being then in the Northerly Signes and conſequently on the North ſide the Horizon,) there is ſix Months Day in the North, and ſix Moneths Night in the South and contrarily from the 13th of *September* to the 10th of *March* (the Sun being then in the Southerly Signes, and therefore on the South ſide the Horizon) there

there is ſix Moneths Day in the South, and ſix Moneths Night in the North.

It is called a Parallel Sphere, becauſe the Sun Moon or Stars in a Diurnal Revolution of the Heavens, neither aſcend higher or deſcend lower, but alwaies move parallel to the Horizon.

The Earth is thus poſited under both the Poles, viz. in 90. degrees of Latitude; as may be ſeen by the Globe, if you turn the Brazen Meridian till either of the Poles be elevated 90 degrees above the Horizon. As in this Figure.

An *Oblique Sphere* hath the Axis of the World neither Direct nor Parallel to the Horizon, but lies aſlope from it. *Oblique Sphere.*

In an Oblique Sphere all the Celeſtial bodies, as Sun Moon or Stars &c. have (in reſpect of the Horizon) oblique and unequal Aſſenſions and Deſcenſions, and all the lines parallel to the Equator

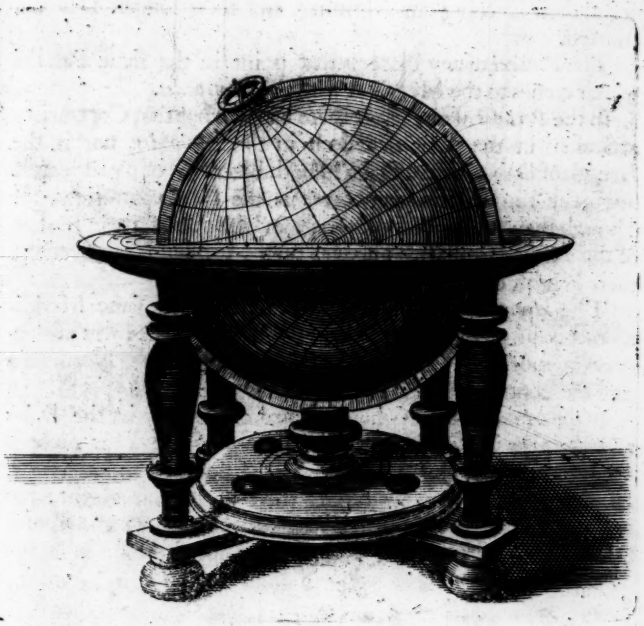
Equator make unequal Angles with the Horizon, and are cut by the Horizon into unequal parts; for thoſe lines towards the elevated Pole, have a greater portion of a circle under the Horizon than above it: only the Equator becauſe it hath the ſame center with the Horizon, doth divide the Horizon into two equal parts, and is alſo divided into two equal parts by the Horizon.

Hence it follows that when the Sun is in any part of the Ecliptick that declines towards the elevated Pole, the dayes in the elevated Hemiſphere ſhall be longer than the Nights: and when the Sun is in any part of the Ecliptick that declines towards the depreſſed Pole, the nights ſhall be longer than the daies. But when the Sun is in the Equinoctial, (becauſe whether the Pole be raiſed or depreſſed) equal portions remain both above and under the Horizon, therefore the daies are of the ſame length with the nights, and the nights with the daies.

Alſo in an Oblique Sphere, all thoſe Stars that have as great or greater number of degrees of Declination than is the elevated Poles Complement of Latitude to 90, never ſett or come under the Horizon, and thoſe Stars that have the ſame Declination about the depreſſed Pole, never riſe.

It is called an *Oblique Sphere* becauſe all the Circles of the Sphere move obliquely about the Horizon.

The Earth is thus obliquely poſited to all thoſe Nations that inhabite under any degree of Latitude either North or Southwards between the Equator and either Pole: as may variouſly be ſeen by the Globe, when the Axis lies not on the Horizon, nor the Equator is parallel to the Horizon: As in this following Figure.



Moreover all places have their *Antipodes*, *Peræci* and *Antæci*.

The *Antipodes* of any Place is the oppoſite degree on the Globe. As if a Perpendicular were let fall from the Place you ſtand on, through the Center of the Earth, and continued till it paſs quite through the Superficies of the Earth, on the other ſide; then in the point where the Perpendicular cuts the Superficies of the Earth on the other ſide, is the *Antipodes* of that Place.

The Inhabitants of any two Places that are in *Antipodes* to each other, go with their Feet directly againſt one another, and have a contrariety in the Seaſons of the Year, and Riſings and Settings of the Sun Moon or Stars, and all other of the Heavenly Bodies: ſo that when with us it is Spring, with them it is Autumn; when with us the Sun Riſes, in our *Antipodes* it Sets; and therefore their Morning is our Evening, their Noon our Mid-

night, their Evening our Morning; and their longeſt Day our ſhorteſt.

The *Periæci* of any Place is that point in the ſame Parallel which comes to the Meridian with the *Antipodes*.

In the *Periæci* of any Place there happens not that Contrariety of Seaſons in the Year that doth in the *Antipodes*, nor in the Length of Daies: for the Daies in both Places are of equal length: but in the times of the day, there is the ſame contrariety, for (though their Spring be our Spring, and the reſt of their Seaſons of the yaer the ſame with ours, yet) their Morning is our Evening, their Night, our Day, &c.

The *Antæci* of any Place is the point under the ſame Meridian that is diſtant from the Equator on the South ſide ſo many degrees as your Place is diſtant from the Equator on the North ſide: and the contrary.

In the *Antæci* there happens not that contrariety in the Daies as doth in the *Antipodes*, but in the Seaſons of the Year there is the ſame contrariety; for in our *Antæci* their Morning is our Morning, their Noon our Noon, their Night our Night: but herein is the difference, their Spring is our Fall, their Summer our Winter, &c. and their longeſt Day our ſhorteſt: as in the *Antipodes*.

The Second BOOK.

Shewing the Practical Uſe of the

GLOBES.

Applying them to the Solution of Aſtronomical *and* Geographical *Problemes.*

PRÆFACE.

Some Advertiſements in Chooſing and Uſing the GLOBES.

1. *SEE the Papers be well and neatly paſted on the Globes: which you may know, if the Lines and Circles deſcribed thereon meet exactly, and continue all the way even and whole: the lines not ſwerving out or in, and the Circles not breaking into ſeveral Arches; nor the Papers either come ſhort, or lap over one the other.*

2. *See that the Culler be tranſparent, and ly not too thick on the Globe; leaſt it hide the ſuperficial deſcriptions.*

3. *See the Globe hang evenly between the Meridian and Horizon, not inclining more to the one ſide than the other.*

4. *See the Globe ſwim as cloſe to the Meridian and Ho-*

rizon as conveniently it may; leſt you be too much puzzeld to find againſt what point of the Globe any degree of the Horizon or Meridian is.

5. *See the Equinoctial line be one with the Horizon, when the Globe is ſet in a* Parallel Sphere.

6. *See the Equinoctial line cut the Eaſt and Weſt point of the Horizon, when the Globe is ſet to an* Oblique Sphere.

7. *See the Degrees of the Meridian marked with* 90. *and* 00. *hang exactly over the Equinoctial line of the Globe.*

8. *See that exactly half the Meridian be above the Horizon, and half under the Horizon: which you may know if you bring any of the Decimal Diviſions to the North Side of the Horizon, and find their Complement to* 90. *in the South.*

9. *See that when the Quadrant of Altitude is Placed at the Zenith, the Beginning of the Graduations reach juſt to the ſuperficies of the Horizon.*

10. *See that while the Index of the Hour Circle (by the motion of the Globe) paſſes from one hour to the other,* 15. *degrees of the Equator paſs through the Meridian.*

11. *If you have A Circle of Poſition, ſee the Graduations agree with thoſe of the Horizon.*

12. *See that your wooden Horizons be made ſubſtantial and ſtrong; for beſides the Inconveniences that thin wood is ſubject unto, in reſpect of warping and ſhrinking) I have had few Globes come to mending that have not had either broken Horizons, or ſome other notorious faults, occaſioned through the ſleightneſs of the Horizon.*

In the Uſing the Globes.

KEep the Eaſt ſide of the Horizon alwaies towards you, unleſs your Propoſition requires the turning of it: which Eaſt ſide you may know by the Word East, placed on the outmoſt verge thereof. For then have you the graduated

ated ſide of the Meridian alwaies towards you, the Quadrant of Altitude before you, and the Globe divided exactly into two equal parts.

So oft as I name to, at, of, *or* under the Meridian, *or* Horizon, *I mean the Eaſt ſide of the Meridian, and Superficies of the Horizon: becauſe the Eaſt of the Meridian paſſes through the North and South points, both of the Globe and Horizon; and agrees juſt with the middle of the Axis: And the Superficies of the Horizon divideth the Globe exactly into two equal parts.*

If you happen to uſe the Globes on the South ſide the Equator, you muſt draw the wyers out of either Pole, and change them to the contrary Poles; putting the longeſt wyer into the South Pole. And becauſe on the other ſide the Equator the South Pole is elevated, therefore you muſt elevate the South Pole of the Globe above the Horizon, according to the South Latitude of your Place; as ſhall be ſhewed hereafter.

In the working ſome Problemes it will be required that you turn the Globe to look on the Weſt ſide thereof: which turning will be apt to jog the Ball, ſo as the degree that was at the Horizon or Meridian, will be moved away, and thereby the Poſition of the Globe altered: To avoid which inconvenience you may make uſe of a Quill, thruſting the Feather end between the Ball and the Brazen Meridian, and ſo wedge it up, without wronging the Globe at all, till your Propoſition be anſwered.

PROB. I.

To find the Longitude *and* Latitude *of Places on the* Terreſtrial Globe.

SEek the Place on the Terreſtrial Globe, whoſe Longitude and Latitude you would know, and bring that Place to the

Braſen Meridian; and I ſee how many degrees of the Equator is cut by the Meridian, from the firſt general Meridian, (which on my Globes paſs through *Gratioſa*, one of the Iſles of the *Azores*,) for that number of degrees is the Longitude of the Place.

Example.

I deſire to know the Longitude of *London*, and cloſe to the name *London* I find a ſmal mark o thus, (which ſmal mark is in ſome Globes and Maps adorned with the Picture of a Steeple, &c.) therefore I do not bring the word *London* to the Meridian, but that ſmal mark; for that alwaies repreſents the Town or Citty ſought for: And keeping the Globe ſteddy in this Poſition, I examine how many degrees of the Equator are contained between the Brazen Meridian, and the firſt general Meridian; which I find to be 28. deg. o. min. Therefore I ſay the Longitude of *London* is 28. deg. o min.

For the Latitude.

See on the Brazen Meridian how many degrees are contained between the Equator and the mark for *London*; which in this Example is $51\frac{1}{2}$: therefore I ſay *London* hath $51\frac{1}{2}$ deg. North Latitude.

PROB. II.

The Longitude *and* Latitude *being known, to Rectifie the Globe fit for uſe.*

1. WHen you rectifie the Globe to any particular Latitude, you muſt move the Brazen Meridian through the notches of the Horizon, till the ſame number of degrees accounted on the Meridian from the Pole (about which the Hour-Circle is) towards the North point in the Horizon (if in North Latitude, and toward the South if in South Latitude) come juſt to the edge of the Horizon.

Example.

By the former Propoſition I found the Latitude of *London* to be $51\frac{1}{2}$ de-

$51\frac{1}{2}$ degrees North Latitude: therefore I count $51\frac{1}{2}$ degrees from the Pole downwards towards my right hand, and turn the Meridian through the notches of the Horizon till those $51\frac{1}{2}$ degrees comes exactly to the uppermost edge of the North point in the Horizon; and then is the Meridian rectified to the Latitude of *London*.

2. Next rectifie the Quadrant of Altitude, after this manner. Screw the edge of the Nut that is even with the graduated edge of the thin Plate, to $51\frac{1}{2}$ degrees of the Brazen Meridian, accounted from the Equinoctial on the Southern side the Horizon, which is just the Zenith of *London*: and then is your Quadrant Rectified.

3. Bring the degree of the Ecliptick the Sun is in that day to the Meridian: which you may learn to know by the next Probleme, and then turn the Index of the Hour Circle to the hour 12. on the South side the Hour Circle, and then is your Hour Circle also Rectified fit to use for that Day.

4. Lastly, If you will rectifie the Globe to correspond in all respects with the Position and Scituation of the Sphear, you must set the four Quarters of the Horizon viz. East. West, North, and South agreeable with the four Quarters of the World; which you may do by the Needle in the bottom of the Horizon; for you must turn the Globe so long till the Needle point just to the Flower de luce. Next you must set the Plain of the wooden Horizon parallel to the Horizon of the World; which you may try by setting a common Level on the four quarters of the Horizon. And then positing the degree of the Ecliptick the Sun is in to the heigth above or depth below the Horizon the Sun hath in Heaven, (as by Prob. 11.) your Globe is made correspondent in all points with the frame of the Sphear, for that particular Time and Latitude.

PROB. III.

To find the Place of the Sun *in the Ecliptick, the Day of the Moneth being first known.*

SEek the Day of the Moneth in the circle of Moneths, upon the Horizon, and right against it in the circle of Signes is the degree of the Ecliptick the Sun is in.

Exam-

Braſen Meridian; and ſee how many degrees of the Equator is cut by the Meridian, from the firſt general Meridian, (which on my Globes paſs through *Gratioſa*, one of the Iſles of the *Azores*,) for that number of degrees is the Longitude of the Place.

Example.

I deſire to know the Longitude of *London*, and cloſe to the name *London* I find a ſmal mark o thus, (which ſmal mark is in ſome Globes and Maps adorned with the Picture of a Steeple, &c.) therefore I do not bring the word *London* to the Meridian, but that ſmal mark; for that alwaies repreſents the Town or Citty ſought for: And keeping the Globe ſteddy in this Poſition, I examine how many degrees of the Equator are contained between the Brazen Meridian, and the firſt general Meridian; which I find to be 28. deg. o. min. Therefore I ſay the Longitude of *London* is 28. deg. o min.

For the Latitude.

See on the Brazen Meridian how many degrees are contained between the Equator and the mark for *London*; which in this Example is $51\frac{1}{2}$: therefore I ſay *London* hath $51\frac{1}{2}$ deg. North Latitude.

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The Longitude *and* Latitude *being known, to Rectifie the Globe fit for uſe.*

1. WHen you rectifie the Globe to any particular Latitude, you muſt move the Brazen Meridian through the notches of the Horizon, till the ſame number of degrees accounted on the Meridian from the Pole (about which the Hour-Circle is) towards the North point in the Horizon (if in North Latitude, and toward the South if in South Latitude) come juſt to the edge of the Horizon.

Example.

By the former Propoſition I found the Latitude of *London* to be $51\frac{1}{2}$ de-

$51\frac{1}{2}$ degrees North Latitude: therefore I count $51\frac{1}{2}$ degrees from the Pole downwards towards my right hand, and turn the Meridian through the notches of the Horizon till those $51\frac{1}{2}$ degrees comes exactly to the uppermost edge of the North point in the Horizon; and then is the Meridian rectified to the Latitude of *London*.

2. Next rectifie the Quadrant of Altitude, after this manner. Screw the edge of the Nut that is even with the graduated edge of the thin Plate, to $51\frac{1}{2}$ degrees of the Brazen Meridian, accounted from the Equinoctial on the Southern side the Horizon, which is just the Zenith of *London*: and then is your Quadrant Rectified.

3. Bring the degree of the Ecliptick the Sun is in that day to the Meridian: which you may learn to know by the next Probleme, and then turn the Index of the Hour Circle to the hour 12. on the South side the Hour Circle, and then is your Hour Circle also Rectified fit to use for that Day.

4. Lastly, If you will rectifie the Globe to correspond in all respects with the Position and Scituation of the Sphear, you must set the four Quarters of the Horizon viz. East. West, North, and South agreeable with the four Quarters of the World; which you may do by the Needle in the bottom of the Horizon; for you must turn the Globe so long till the Needle point just to the Flower de luce. Next you must set the Plain of the wooden Horizon parallel to the Horizon of the World; which you may try by setting a common Level on the four quarters of the Horizon. And then positing the degree of the Ecliptick the Sun is in to the heigth above or depth below the Horizon the Sun hath in Heaven, (as by Prob. 11.) your Globe is made correspondent in all points with the frame of the Sphear, for that particular Time and Latitude.

PROB. III.

To find the Place of the Sun *in the Ecliptick, the Day of the Moneth being first known.*

SEek the Day of the Moneth in the circle of Moneths, upon the Horizon, and right against it in the circle of Signes is the degree of the Ecliptick the Sun is in.

Exam-

Example

Imagine the Day to be given is May 10. therefore I ſeek on the Horizon in the Circle of Moneths, for May, and find the Moneths divided into ſo many parts as there is Daies in the Moneth; which parts are marked with Arithmetical figures, from the beginning of the Moneth to the end, and denote the number of the day of the Moneth that each Diviſion repreſents: therefore among the Diviſions I ſeek for 10, and directly againſt it in the Circle of Signes I find ♉ 29 degrees. Therefore I ſay, May 10 the Suns Place is in 29 degrees of ♉.

But note, that if it be Leap Year, inſtead of the 10 of May you muſt take the 11. of May becauſe February having in a Leap Year 29 Daies, the 29. of February muſt be reckoned for the firſt of March, and the firſt of March for the ſecond of March; the ſecond of March for the third of March; and ſo throughout the year.

The Leap Year is cauſed by the ſix od hours more than 365. daies that are aſſigned to every common Year: ſo that in a Revolution of 4. Years, one Day is gained, which is added to February; and therefore February hath every fourth or Leap Year 29. Daies.

PROB. IIII.

To find the Day of the Moneth, the Place of the Sun being given.

AS in the laſt Porbleme it was your task to find on the Horizon the Day of the Moneth firſt, ſo now you muſt firſt ſeek the Signe and degree the Sun is in, and againſt it in the Circle of Moneths you ſhall ſee the Day of the Moneth: as againſt ♉ 29 you have May 10.

PROB. V.

The Place of the Sun given to find its Declination.

HAving by the third Probleme found the Suns Place on the Plain of the Horizon, you muſt ſeek the ſame degree in the

the Ecliptick, on the Globe; then bring that degree to the Brazen Meridian; and the number of degrees intercepted between the Equinoctial and the degree juſt over the degree of the Ecliptick the Sun is in, is the Declination of the Sun for that Day: and bears its Denomination of North or Souh, according to its Poſition either on the North or South ſide the Equinoctial.

Example.

By the third Probleme aforeſaid, of *May* 10. I find ♉ 29. the Suns Place; Therefore I ſeek in the Ecliptick Line on the Globe for ♉ 29 and bring it to the Eaſt ſide of the Brazen Meridian, which is the graduated ſide; and over ♉ 29. I find on the Brazen Meridian 20. deg. 5 min. (numbred from the Equinoctial:) and becauſe ♉ is on the North ſide the Equinoctial, therefore I ſay, The Sun hath *May* 10 North Declination 20 degrees 5 min.

PROB VI.

The Place of the Sun given to find its Meridian Altitude.

THe Globe rectified, Bring the degree of the Sun to the Meridian (or which is all one, the degree of the Ecliptick the Sun is in;) and the number of degrees contained between the Horizon and the Suns Place in the Meridian is the number of degrees that the Sun is Elevated above the Horizon at Noon, or (which is all one) the Meridian Altitude of the Sun.

Example.

To know what Meridian Altitude the Sun hath here at London, *May* 10. I bring the Suns Place (found by the third Probleme (to the Meridian and count on the Meridian the number of degrees contained between the Horizon and the degree juſt over the Suns Place; which in this Example I find to be 58½. Therefore I ſay the Suns Meridian Altitude *May* 10. is here at *London* 58 ½ degrees.

PROB. VII.

The Suns Place given, to find the Hour of Sun Riſing, and the length of the Night and Day.

THe Globe and Hour Index rectified, Seek the degree the Sun is in on the Globe, and bring that degree to the Eaſtern Side of the Horizon; and the Index of the Hour Circle will point at the Hour of Sun Riſing.

Example.

To know the Hour of Sun Riſing here at *London*, May 10. The Suns Place (as before) is ♉ 29. Therefore the Globe being rectified (as before) I ſeek ♉ 29. degrees on the Globe, and bring that degree to the Eaſt Side of the Horizon; and looking on the Index of the Hour Circle, I find it point at 4. a clock and $\frac{1}{6}$ part of an Hour more towards 5; therefore I ſay *May* 10. the Sun riſes here at *London* at $\frac{1}{6}$ (which is 10 minutes) after 4 a clock in the Morning.

If you double 4 hours 10. minutes it gives you the length of the Night, 8. hours. 20 minutes: And if you ſubſtract the length of the Night 8, hours 20 minutes from 24. hours, the length of Day and Night; it leaves the length of the Day 15. hours 40. minutes.

PROB. VIII.

To find the Hour of Sun Set.

TUrn the Place of the Sun to the Weſt ſide of the Horizon, and the Index of the Hour Circle ſhewes on the Hour-Circle the hour of Sun ſet; which on the 10th of *May* aforeſaid, is $\frac{5}{6}$ parts of an hour after 7. a clock at Night, viz. the Sun Sets at 48. minutes paſt 7. a clock.

PROB.

PROB. IX.

To find how long it is Twilight in the Morning, and Evening.

TWilight is that promiſcuous and doubtfull light which appears before the Riſing of the Sun in the Morning, and continues after the ſetting of the Sun in the Evening: It is made by the extenſion of the Suns beames into the Vapours of the Air, when the Sun is leſs then 18. deg. below the Horizon: for the Sun ere it Riſes, and after it Sets, ſhoots forth its Beames through the Air, and ſo illuminates the Vapors of the Air; which illumination does by degrees enlighten the Horizon: and ſpreads through the Zenith, even into the Weſt ere the Sun Riſes; and alſo continues above the Horizon after the Sun ſets.

Now though it be Twilight when the Sun is 18 degrees below the Horizon; yet the duration of Twilight (is alterable both in reſpect of *Time*) and *Place*, for at ſuch Time as the Sun is fartheſt diſtant from any Place, the Twilight ſhall be greater, then when it is neareſt. And in reſpect of *Place*, All Places that have great Latitude from the Equator, have longer Twilight than thoſe that are neerer to the Equator: for as Authors ſay, under the Equator there is no Twilight; when again in many Climes both Northward and Southward, the Nights are indeed no Nights but only (as it were) a little over-ſpread with an obſcure ſhade; and it is either increaſed or diminiſhed according to the mutation of Meteorological Cauſes.

Therefore to know the beginning of Twilight in the Morning here at *London*, *May* 10; you muſt (having the Globe rectified) turn the degree of the Ecliptick which is oppoſite to the Place of the Sun till it be elevated 18. degrees in the Quadrant of Altitude above the Horizon in the Weſt; So ſhall the Index of the Hour-Circle point at the Hour that Twilight begins: then ſubſtract the Hour and Minute that Twilight begins from the Hour and Minute of Sun Riſing, if in the Morning, or ſubſtract the Hour of Sun ſet from the hour of Twilight if at night, and the remainder is the length of Twilight.

Example.

The Globe Quadrant and Hour-Index being rectified, as before;

fore; and the Suns Place given ♉ 29. I ſeek the oppoſite degree on the Globe after this manner: I bring ♉ 29. to the Meridian, and obſerve what degree of the Ecliptick the oppoſite part of the Meridian cuts; and becauſe I find it cuts ♏ 29. therefore I ſay ♏ 29. is oppoſite to ♉ 29. having found the oppoſite degree, I bring it into the Weſt, and alſo the Quadrant of Altitude, and joyn ♏ 29 to 18. degrees (accounted upwards on the Quadrant) ſo ſhall ♉ 29 be depreſſed 18 degrees in the Eaſt ſide the Horizon: Then looking What hour the Hour-Index points at in the Hour-Circle, I find it to be 1 Hour 8. Min. which ſhews that Twilight begins at 8. Minutes paſt 1. a clock in the Morning.

And if you ſubſtract 1. Hour 8 Minutes, from 4. Hours 11. Minutes, the time of Sun riſing found by the 7th Probleme, it leaves 3. Hours 3. Minutes for the length of Twilight: And if you double 1. Hour 8. Minutes, the beginning of Twilight, it makes 2. Hours 16. Minutes for the intermiſſion of Time between Twilight in the Evening, and Twilight in the Morning: So that *May* 10. abſolute Night is but 2. Hours 16. Minutes long, here at *London*.

The reaſon why you bring the degree oppoſite to the Suns Place to the Weſt, is, becauſe the Quadrant containing but 90. degrees will reach no lower then the Horizon; but this Probleme requires it to reach 18. degrees beneath it: therefore by this help, you have the Propoſition anſwered, as well as if the Quadrant did actually reach 18. degrees below the Horizon. This ſhift you may have occaſion to make in ſome other Problemes.

If you would know when Twilight ends after the Sun ſets; you ſhall find it by bringing the degree of the Ecliptick oppoſite to the Place of the Sun to 18. degrees of the Quadrant of Altitude, on the Eaſt ſide the Horizon; for then ſhall the Index of the Hour-Circle point at 10 Hours 52. Minutes: which ſhews that it continues Twilight till 52. Minutes paſt 10. a clock at Night, *May* 10 here at *London*.

PROB. X.

The Suns Place given, to find its Amplitude; And alſo to know upon what point of the Compaſs it Riſeth.

THe Globe &c. rectified: Bring the Suns Place to the Eaſt ſide the Horizon; and the number of degrees intercepted between

between the Eaſt point of the Horizon and the Suns Place, is the number of degrees of Amplitude that the Sun hath at its Riſing; and bears its denomination either of North or South according to its inclination to either point in the Horizon.

Or if you would know upon what point of the Compaſs the Sun Riſes, Look but in the Circle of Winds, and againſt the Place of the Sun you have the name of the point of the Compaſs upon which the Sun Riſeth.

Examples of both.

May 10. the Suns Place is ♉ 29 Therefore the Globe being rectified; I bring ♉ 29. to the Eaſt ſide the Horizon, and find it touch aganiſt 33, degrees 20, Minutes from the Eaſt point towards the North: Therefore I ſay the Sun hath North Amplitude, 33 degrees 20. Minutes.

And to know upon what point of the Compaſs the Sun riſes; I keep the Globe to its Poſition, and look in the Circle of Winds, in the outmoſt verge of the Horizon, and find the Suns Place againſt the Wind named North Eaſt and by Eaſt; Therefore I ſay *May* 10. here at *London* the Sun riſeth upon the North Eaſt and by Eaſt point of the Compaſs.

PROB. XI.

The Day of the Moneth and Hour of the Day given, to find the Heigth of the Sun, in any given Latitude.

THe Globe &c. Rectified, Turn about the Globe till the Index of the Hour-Circle point (in the Hour-circle) to the Hour of the Day: Then bring the Quadrant of Altitude to the Suns Place in the Ecliptick and the degree on the Quadrant which touches the Suns Place, ſhall be the number of degrees of the Suns Altitude.

Example.

May 10. here at *London*; At 53. Minutes paſt 8. a clock in the Morning I would know the Height of the Sun above the Horizon. Therefore I turn about the Globe till the Index of the

Hour-Circle comes to 53. Minutes paſt 8. a clock (which is almoſt 9. (in the Hour-Circle: And keeping the Globe to this Poſition, I bring the Quadrant of Altitude to the Suns place, *viz.* ♉ 29. (found by the third Probleme (and becauſe the Suns Place touches upon 40 degrees of the Quadrant, therefore I ſay *May* 10. 53. Minutes paſt 8 a clock in the Morning, here at *London*, The Sun is juſt 40. degrees above the Horizon; or which is all one, hath 40. degrees of Altitude.

PROB. XII.

The Altitude of the Sun, and day of the moneth given, to find the hour of the day.

An Hour defined.

AN Hour is the 24th part of a Day and a Night, or the ſpace of Time that 15 degrees of the Equator takes up in paſſing through the Meridian; for the whole Equator which contains 360 degrees, paſſes through the Meridian in 24 Hours, therefore 15 degrees which is the 24th part of 360. paſs through in one Hour. Theſe Hours are vulgarly divided into halfs, quarters and half quarters; but Mathematically into Minutes, Seconds, Thirds Fourths, &c. A Minute is the 60 part of an Hour. ſo that 60 minutes make an Hour; 30 half an Hour, 15 a quarter of an Hour: A Second is the 60th part of a Minute: a Third is the 60th part of a Second: a Fourth is the 60th part of a Third: and ſo you may run on to Fifths, Sixths, Sevenths, &c. if you pleaſe. 12 of theſe Hours make a Day, and 12 more make a Night: ſo that Day and Night contain 24 Hours, as aforeſaid; which are vulgarly numbred from Noon, with 1, 2, 3, to 12, at Night: and then begin again with 1, 2, 3, till 12, at Noon: But by Aſtronomers they are Numbred from Noon with 1, 2, 3, &c. till 12 at Night; and ſo forward to 13, 14, 15, till 24, which is juſt full Noon the next Day. Yet in this Treatiſe I ſhall mention the Hours as they are vulgarly counted, viz. from 1 after noon, till 12 at Night, and call the hours after Midnight by 1, 2, 3, 4. &c. in the Morning, to 12. at Noon again, the next Day. But to the operation.

Minutes, Seconds, and Thirds, &c. defined.

The Globe, &c. Rectified. Bring the place of the Sun to the number of degrees of Altitude, accounted upon the Quadrant of Alti-

Altitude, and the Hour-Index ſhall point at the Hour in the Hour-Circle: yet herein reſpect muſt be had to the Fore or After Noons Elevation; as ſhall be ſhewed in the next Probleme.

Example.

May 10. The Sun is elevated 40 degrees above the Horizon, here at *London:* Therefore having found the place of the Sun, by the third Probleme, to be ♉ 29. I move the Globe and Quadrant till I can joyn the 29th degree of ♉ to the 40th degree upon the Quadrant of Altitude; and then looking on the Hour-circle, I find the Index point at 53. minutes paſt 8. a clock, for the Fore noon Elevation; and at 3. hours 7. minutes for the After noons Elevation. Therefore if it be Fore-noon, I ſay It is 53. minutes paſt 8. a clock in the Morning. But if it be After-noon, I ſay it is 7 minutes paſt 3 a clock in the After-noon.

PROB. XIII.

How to know whether it be Before or Afternoon.

HAving made one Obſervation, you muſt make a ſecond a little while after the firſt; and if the Sun increaſe in Altitude, it is before noon: but if it decreaſe in Altitude, it is after noon.

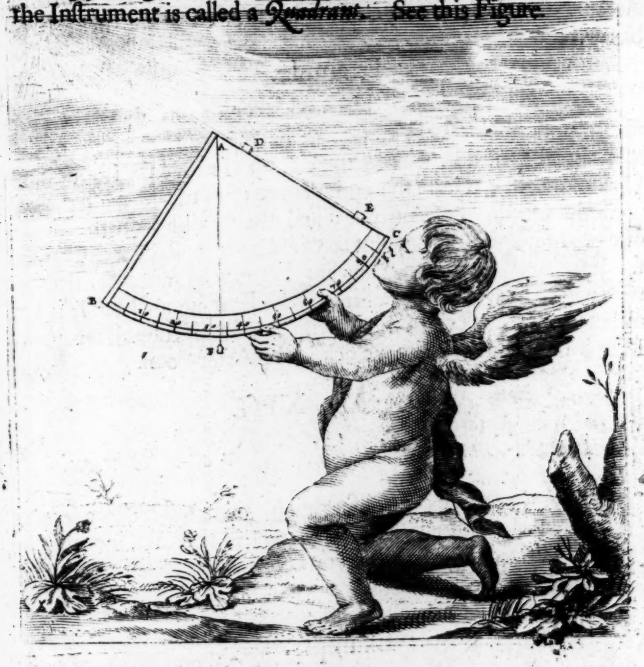
Example.

The Sun was at 8 hor. 53 min. elevated 40 degr. above the Horizon: a little while after (ſuppoſe for examples ſake a quarter of an hour,) viz. at 9 hor. 8 min. I obſerve again the heighth of the Sun, and find it 42 degrees high; ſo that the Altitude is increaſed 2 degrees; Therefore I ſay, It is Fore-noon: But if the Sun had decreaſed in Altitude, I ſhould have ſaid, It is After-noon.

How to take Altitudes by the Quadrant, Aſtrolabe, *and* Croſſe ſtaffe.

There are divers Inſtruments whereby Altitudes may be taken: but the moſt in uſe are the *Quadrant*, *Aſtrolabe*, and *Croſſe-ſtaffe*. A *Quadrant* is an Inſtrument comprehended between two ſtraight lines making a right Angle, and an Arch

Arch discribed upon the Right Angle, as on the Center, containing 90. degrees, which is a quarter of a Circle: and therefore the Instrument is called a *Quadrant*. See this Figure



A represents the Center, upon which is fastned a Plumb-line, A B the one side, A C the other side, upon which the Sights are placed: B C the Arch or Quadrant, which is divided into 90 equal parts, and numbred from B to C D, one Sight, E the other Sight: F the Plumbet fastned to the Plumb-line.

When by this Instrument you would observe the height of the Sun, you must turn the Center A to the Sun, and let the beams thereof dart in at the hole in the first Sight D, through the hole in the second Sight E; so shall the Plumb-line ly upon the degree in the Limb of the Suns Elevation: As if the plumb-line ly upon the 20th degree, then shall the Altitude be 20. degrees; if on 25. the Altitude shall be 25. degrees: and so for any number of Degrees the thred or plumb-line lies on, the same number of Degrees is the Altitude of the Sun.

But

But if it be a Star whose Altitude you would observe; you must hold up the Quadrant, and joyn the Limb to your Cheek-bone, and turn the Center towards the Star: then winking with one Ey, look through the holes of the Sights with the other Ey, till you can see the Star through those holes; so shall the Plumb-line (as before in the Sun) hang upon the degree in the Limb of the Stars Elevation.

Another sort of Quadrants is made with a moveable Index, as is represented in this Figure.

A is the center, A B and A C the two sides, B C the limb, D E two Sights fixed upon a moveable Index or Label; F G two other Sights, for observing the Horizon.

When by this Quadrant you would observe an Altitude, the side B A must be parallel to the Horizon, and the Index must be moved till the Object (be it either the Sun Moon or any Star) be seen through the holes or slitts of the Sights placed on the Index; for then the Arch D B shall be the Elevation required. You

may know when the ſide B A is parallel to the Horizon, by obſerving the parting of Heaven from the Earth through the Sights on the Side B A.

To take Altitudes with the Aſtrolabe.

The Aſtrolabe is a round Inſtrument flat on either ſide, upon one of the flatts or plains is deſcribed a Circle as B C D E, divided into 360 equal parts or degrees, numbred from the line of Level B A C, with 10, 20, &c. to 90. in the perpendicular D C. Upon the perpendicular is faſtned a Ring, as F, ſo as the Inſtrument hanging by it, the line of Level may hang parallel to the Horizon: Upon the Center is a moveable Label or Ruler, as G H, whereupon is placed two Sights, as I K.

If you deſire further inſtructions for making this Inſtrument you may peruſe Mr *Wright* in his *Diviſion of the whole Art*

of

of Navigation, annexed to his *Correction of Errors:* where he alſo ſhews the uſe of it at large; which in brief is as follows.

You muſt hold the *Aſtrolabe* by the Ring in your left hand, and turning your right ſide to the Sun, lift up the Label with your right hand, till the beams of the Sun entring through the hole of the uppermoſt Vane or Sight, doth alſo peirce through the hole in the nethermoſt Vane or Sight; and the degree and part of degree that the Label lies on is the height of the Sun above the Horizon.

But if it be a Star you would obſerve; you muſt uſe the *Aſtrolabe* as you were directed to uſe the *Quadrant*, holding it up to your Cheek bone, and looking through the Sights, &c.

To take Altitudes with the *Croſſe-ſtaffe.*

This Inſtrument conſiſts of a Staffe about a yard long, and three quarters of an inch ſquare: Upon it is fitted a Vane, (or ſometimes two or three,) ſo as it may ſlide pretty ſtiff upon the Staffe, and ſtand at any of the diviſions it is ſet to.

The making is taught by Mr *Wright*, aforesaid: But the use is as follows.

You must put that end of the Crosse-staff which is next 90. degrees to your Cheek-bone, upon the outter corner of your Ey and holding it there steddy, you must move the Vane till you see the Horizon joyned with the lower end thereof, and the Sun or Star with the higher end; then the degree and part of degree which the Vane cutteth upon the Staff, is the heighth of the Sun or Star.

Some of these waies for taking Altitudes have been formerly taught by others that have treated upon the Use of Globes: and therefore because some would be apt to think this Treatise uncompleat if I did not shew these waies also, I have thought fit to insert them: Yet the same things may be performed by the Globe alone, without troubling your self with multiplicity of Instruments; if your Globe be made with a hollow Axis; for then if the Globe stand Horizontal, you shall by observing the Object through the Axis have the degree of Elevation, noted by the superficies of the Horizon.

PROB. XIV.

To observe with the Globe the Altitude of the Sun.

PLace the Globe so that the upper plain of the Horizon may stand parallel to the Plain of the Horizon of your Place; as was taught by the Second Probleme; then turn the North Pole towards the Sun, and place it higher or lower, by moving the Meridian through the notches of the Horizon, till the beams of the Sun pierce quite through the Axis of the Globe: So shall the arch of the Meridian comprehended between the Pole and the edge of the Horizon, be the number of degrees that the Sun is elevated above the Horizon.

Example.

March 20. just at noon, here at *London*, I would observe the Meridian Altitude of the Sun. Therefore placing the Horizon Horizontal, as by the Second Probleme: I turn the North Pole

Pole towards the Sun, and move it with the Meridian upwards or downwards, either to this ſide or that, till I can fit it to ſuch a poſition that the Sun beams may dart quite through the hollow Axis of the Globe; which when it does, I look on the Meridian and find 42 degrees 25. min. comprehended between the Pole and the ſuperficies or the Horizon: Therefore I ſay the Meridian Altitude of the Sun *March* 20. here at *London*, is 42. degrees 25. min.

PROB. XV.

To find the Elevation of the Pole, by the Meridian Altitude of the Sun, and Day of the Moneth given.

THe Day of the moneth is *March* 20. By the 4th Prob. you may find the place of the Sun to be ♈ 10. Therefore bring the place of the Sun to the Meridian, and elevate it above the Horizon the ſame number of degrees it hath in Heaven; ſo ſhall the arch of the Meridian comprehended between the Pole and the Horizon, be the elevation of the Pole in your Place.

Otherwiſe.

The Day of the Moneth given is *March* 20. ſo that by the fourth Prob. you have the Suns place ♈ 10; and by the fifth, the Declination of the Sun 3. 55. North: therefore the Declination being North, and you on the North ſide the Equator; you muſt ſubſtract 3. 55. from the Meridian Altitude 42. 25. and there remains 38. 30 for the heighth of the Equinoctial above the Horizon: But if your Declination had been South, you muſt have added 3. 55. to the Meridian Altitude, and the Sum would have been the Elevation of the Equinoctial. Having the Elevation of the Equinoctial, you may eaſily have the Elevation of the Pole; for the one is alwaies the Complement of the other to 90. Thus the heighth of the Equinoctial 38. 30. ſubſtracted from 90. leaves 51. 30. for the Elevation of the Pole, here at *London*. And thus it follows, that the Latitude of any Place from the Equinoctial, is alwaies equal to the Elevation of the

The making is taught by Mr *Wright*, aforeſaid: But the uſe is as follows.

You muſt put that end of the Croſſe-ſtaff which is next 90. degrees to your Cheek-bone, upon the outter corner of your Ey and holding it there ſteddy, you muſt move the Vane till you ſee the Horizon joyned with the lower end thereof, and the Sun or Star with the higher end; then the degree and part of degree which the Vane cutteth upon the Staff, is the heighth of the Sun or Star.

Some of theſe waies for taking Altitudes have been formerly taught by others that have treated upon the Uſe of Globes: and therefore becauſe ſome would be apt to think this Treatiſe uncompleat if I did not ſhew theſe waies alſo, I have thought fit to inſert them: Yet the ſame things may be performed by the Globe alone, without troubling your ſelf with multiplicity of Inſtruments; if your Globe be made with a hollow Axis; for then if the Globe ſtand Horizontal, you ſhall by obſerving the Object through the Axis have the degree of Elevation, noted by the ſuperficies of the Horizon.

PROB. XIV.

To obſerve with the Globe the Altitude of the Sun.

PLace the Globe ſo that the upper plain of the Horizon may ſtand parallel to the Plain of the Horizon of your Place; as was taught by the Second Probleme; then turn the North Pole towards the Sun, and place it higher or lower, by moving the Meridian through the notches of the Horizon, till the beams of the Sun pierce quite through the Axis of the Globe: So ſhall the arch of the Meridian comprehended between the Pole and the edge of the Horizon, be the number of degrees that the Sun is elevated above the Horizon.

Example.

March 20. juſt at noon, here at *London*, I would obſerve the Meridian Altitude of the Sun. Therefore placing the Horizon Horizontal, as by the Second Probleme: I turn the North Pole

Pole towards the Sun, and move it with the Meridian upwards or downwards, either to this ſide or that, till I can fit it to ſuch a poſition that the Sun beams may dart quite through the hollow Axis of the Globe; which when it does, I look on the Meridian and find 42 degrees 25. min. comprehended between the Pole and the ſuperficies of the Horizon: Therefore I ſay the Meridian Altitude of the Sun *March* 20. here at *London*, is 42. degrees 25. min.

PROB. XV.

To find the Elevation of the Pole, by the Meridian Altitude of the Sun, and Day of the Moneth given.

THe Day of the moneth is *March* 20. By the 4th Prob. you may find the place of the Sun to be ♈ 10. Therefore bring the place of the Sun to the Meridian, and elevate it above the Horizon the ſame number of degrees it hath in Heaven; ſo ſhall the arch of the Meridian comprehended between the Pole and the Horizon, be the elevation of the Pole in your Place.

Otherwiſe.

The Day of the Moneth given is *March* 20. ſo that by the fourth Prob. you have the Suns place ♈ 10; and by the fifth, the Declination of the Sun 3. 55. North: therefore the Declination being North, and you on the North ſide the Equator; you muſt ſubſtract 3. 55. from the Meridian Altitude 42. 25. and there remains 38. 30 for the heighth of the Equinoctial above the Horizon: But if your Declination had been South, you muſt have added 3. 55. to the Meridian Altitude, and the Sum would have been the Elevation of the Equinoctial. Having the Elevation of the Equinoctial, you may eaſily have the Elevation of the Pole; for the one is alwaies the Complement of the other to 90. Thus the heighth of the Equinoctial 38. 30. ſubſtracted from 90. leaves 51. 30. for the Elevation of the Pole, here at *London*. And thus it follows, that the Latitude of any Place from the Equinoctial, is alwaies equal to the Elevation of the

Pole: for between the Zenith and the Equinoctial is contained the Complement of the Heighth of the Equinoctial above the Horizon to 90.

PROB. XVI.

To take the Altitude of any Star above the Horizon; by the Globe.

THe Horizon of the Globe ſet parallel to the Horizon of the World, as before: Turn the North Pole towards the Star, and when you can ſee the Star through the Axis, the Northern notch of the Horizon will cut the degree of Elevation on the Meridian.

Example.

April 19. at 11. a clock at Night, I would obſerve the Altitude of *Spica Virgo*. Therefore I ſet the Horizon parallel to the Horizon of the World, as by the Second Probleme, and turn the Northern Pole till it point towards the Star: Then looking in at the South Pole of the Globe through the Axis, I ſhall ſee the Star, and have on the Meridian the Queſtion reſolved. But if it point not exactly, then I move the North Pole either upwards or downwards to the right or to the left hand according as I may find occaſion, till I can ſee the Star through the Axis: and then the edge of the notch in the Horizon cuts 28. degrees 59. min. on the Brazen Meridian. Therefore I ſay *April* 19. at 11. a clock at Night, here at *London*, the Altitude of *Spica* ♍ is 28 degr. 59 min. above the Horizon.

PROB. XVII.

By the Meridian Altitude of any Star given, to find the Height of the Pole.

JOyn the Star to the Meridian, and place it to the Altitude obſerved; ſo ſhall the number of degrees intercepted between the Pole and the Horizon, be the Elevation of the Pole.

Exam-

Example.

Spica Virgo is obſerved to have 28. degrees 59. min Meridian Altitude; therefore I bring *Spica Virgo* to the Meridian, and raiſe it or depreſs it higher or lower as I find occaſion, till it is juſt 28. degrees 59 min. above the Horizon: Then I count the number of degrees between the Pole and the Horizon, and find them 51. Therefore I ſay the Elevation of the Pole is here at *London* 51 ½. Yet note, If the Star whoſe Altitude you obſerve have fewer number of degrees of Declination from the Pole then the Elevation of the Pole, you may be apt ot miſtake in its coming to the Meridan; for thoſe Stars never ſet; and therefore are twice Viſible in the Meridian in 24 hours, once above the Pole, and once under the Pole.

If your Star have greater Altitude then the North Star, it is above the Pole; but if it have leſs, it is below the Pole: ſo that if you know but whether it be above or below, it is enough; for ſo you may accordingly raiſe it to the Altitude on the Meridian it hath in Heaven, and joyn it to the Meridian either above or beneath the Pole, as the Star is placed in Heaven: and then the arch of the Meridian comprehended between the Pole and the Horizon, is the Elevation of the Pole: as aforeſaid.

Otherwiſe.

Having the Meridian Altitude of the Star, you muſt find its Declination by the 27. Problem: and if the Declination be South, and you on the North ſide the Equator, you muſt ad the Declination to the Meridian Altitude, and the ſum of both makes the Altitude, of the Equinoctial: But if the Declination be North, and you on the North ſide the Equator, you muſt ſubſtract the Declination from the Meridian Altitude, (as was taught by the 15 Prob. in the Example of the Sun, (and the remainder is the Altitude of the Equinoctial. Then (as was taught by the 15 Probleme aforeſaid) ſubſtract the Altitude of the Equinoctial from 90. the Remainder is the Elevation of the Pole in your Place.

Exam-

Example.

By the laſt Probleme the Meridian Altitude of *Spica Virgo* was 28. degrees 5. min. and the Declination of *Spica* by the 27th Probleme is found 9. degrees 3. min. South: therefore becauſe the Declination is South, I add 9. degrees 3. min. to the Meridian Altitude, which makes 38. degrees 30. min. for the Elevation of the Equinoctial: which 38. deg. 30. min. ſubſtracted from 90. leaves 51. deg. 30. min. for the Elevation of the Pole here at *London*.

PROB. XVIII.

Another way to find the height of the Pole by the Globe; if the place of the Sun be given: And alſo to find the Hour of the Day and Azimuth, and Almicantar of the Sun.

THis muſt be performed by help of a *Spherick Gnomon*, (as *Blaew* calls it,) which is a ſmal Pin or Needle fixed perpendicularly into a ſmal Baſis with an hollow concave bottom, that it may ſtand upon the convexity of the Globe. Therefore the Horizon of the Globe being ſet parallel to the Horizon of the World, (as by the Second Probleme) the Spherick Gnomon muſt be ſet exactly upon the place of the Sun; and then turning the Globe about (upon its Axis either from Eaſt to Weſt, or contrarily from Weſt to Eaſt; or elſe by the Meridian through the notches of the Horizon) till the Spherick Gnomon caſt no ſhadow on any ſide thereof, you have on the Meridian in the North point of the Horizon the number of degrees that the Pole is elevated above the Horizon.

Example.

Imagine the four Quarters of the Horizon of the Globe correſpond with the four Quarters of the Horizon of the World; and the plain of the Horizon of the Globe is parallel to the plain of the Horizon of the World: The Suns place is ♉ 29. which

which I find on the Globe, and place the Spherick Gnomon thereon; then at a gueſs I move the Globe both on its Axis, and by the Meridian, (as neer as I can) ſo as the Spherick Gnomon may caſt no ſhadow; yet if it do, and the ſhadow fall towards the North Pole; then I elevate the North Pole more till the ſhadow falls juſt in the middle of its ſelf: but if the ſhadow fall downwards, towards the South Pole, then I depreſs the North Pole: if the ſhadow fall on the Eaſt ſide, I turn the Globe on its Axis more to the Weſt; and if the ſhadow fall to the Weſt, I turn the Globe more into the Eaſt: and the degree of the Meridian which the North Point of the Horizon touches, is the degree of the Poles elevation: which in this Example is $51\frac{1}{2}$. the Latitude of the City of *London.*

By this Operation you have alſo given the hour of the Day in the Hour-Circle, if you keep the Globe unmoved: and the Azimuth, and Almicanter, if you apply but the Quadrant of Altitude to the Place of the Sun, as by the 22, and 23. Problemes.

PROB. XIX.

To obſerve by the Globe the Diſtance of two Stars.

YOu muſt pitch upon two Stars in the Meridian; and obſerve the Altitude of one of them firſt, and afterwards the Altitude of the other: then ſubſtract the leſſer Altitude from the greater, and the remiander ſhall be the diſtance required.

Example.

March 7. at 11. a clock at Night here at *London*, I ſee in the Meridian the two Stars in the foremoſt Wheels of the *Waggon*, in the Conſtellation of the *Great Bear*, called by Sea-men the *Pointers*, (becauſe, they alwaies point towards the Pole-Star) Therefore to obſerve the diſtance between theſe two Stars, I firſt obſerve (as by the laſt Probleme) the Altitude of the moſt Northern to be 77. degrees 59. minutes, and ſet down that number of degrees and minutes with a Pen and Inck on a Paper, or with a peece of Chalk or a Pencil on a Board: and afterwards I obſerve the Altitude of the other Star which is un-

der it, as I did the first, to be 83 degrees 21 min. and set that number of degrees and minutes also down, under the other number of degrees and minutes: Then by substracting the lesser from the greater, I find the remainder to be 5 degrees 22. min. which is the distance of the two Stars in the *Great Bear*, called the *Pointers*.

PROB. XX.

How you may learn to give a guess at the number of degrees that any two Stars are distant from one another: or the number of degrees of Altitude the Sun or any Star is elevated above the Horizon: only by looking up to Heaven, without any Instrument.

BEtween the Zenith and Horizon is comprehended an Arch of a circle containing 90 degrees; so that if you see any Star in or neer the Zenith, you may know that Star is 90 or neer 90 degrees high; and by so much as you may conceive it wants of the Zenith, so much you may guess it wants of 90 degrees above the Horizon. By this Rule you may guess at an Arch of Heaven containing 90 degrees; or at an Arch of Heaven containing 45 degrees; if by your imagination you divide the whole Arch into two equal parts, for then shall each of them contain 45 degrees; And if by your imagination you divide the Arch of 90 into 3 equal parts, each division shall contain an Arch of 30 degrees, &c. But this way is a little too rude for guessing at Stars elevated but few degrees, or for Stars distant but few degrees from one an other. Therefore that you may learn to guess more precisely at distances in Heaven, you may either with a Quadrant Astrolobe, or the Globe, find the exact distance of any two known Stars that are but few degrees asunder, and by a little revolving the distance of those Stars in your fancy, you may at length so imprint their distance in your memory, that you may readily guess the distance of other Stars by the distance of them.

Example.

You may find either by the Globe, Quadrant, or Astrolabe, (for

(for they all agree) 3 degrees comprehended between the firſt Star in *Orions Girdle*, and the laſt; therefore by a little conſidering that diſtance, you may imprint it in your fancy for 3 degrees, and ſo make it applicable to other Stars, either of the ſame diſtance, or more, or leſs: And the *Pointers* (by the laſt Probleme) are diſtant from one another 5 degrees and almoſt an half: Theſe are alwaies above our Horizon, and therefore may alwaies ſtand as a Scale for 5 and an half degrees; So that by theſe for 5 ½ degrees, and thoſe in *Orions Girdle* for 3 degrees, and others obſerved, either of greater or leſſer diſtance, you may according to your own Judgement ſhape a gueſs, if not exactly, yet pretty neer Truth, when you come to other Stars. Thus you may exerciſe your fancy upon Stars found to be 10. or 15. degrees aſunder, or more, or leſs; and with a few experiments of this nature enure your judgement to gueſs at diſtances, and enable your memory to retain thoſe gueſſes.

This way of gueſſing will be exact enough for finding the hour of the night by the Stars, for moſt common Uſes; or the hour of the day, by gueſſing at the Altitude of the Sun; if after you have gueſſed at the Altitude, you work as was taught by Prob 12. for the hour of the day: and as ſhall be taught in the next Probleme for the hour of the night.

PROB. XXI.

The Day of the Moneth and Altitude of any Star given; to find the Hour of the Night.

THe Globe, Quadrant, and Hour Index rectified: Bring the Star on the Globe to the ſame number of Degrees on the Quadrant of Altitude that it hath in Heaven: So ſhall the Index of the Hour-circle point in the Hour-circle at the Hour of the Night.

Example.

March 10. The Altitude of *Arcturus* is 35. degrees above the Horizon, here at *London*: Therefore having the Globe,

Quadrant, and Hour-Index rectified, I bring *Arcturus* on the Globe to 35. degrees on the Quadrant of Altitude: and then looking in the Hour-circle, I find the Index point at 10 a clock; which is the Hour of the Night.

PROB. XXII.

The Place of the Sun, and Hour of the Day given; to find its Azimuth in any aſſigned Latitude.

THe Globe, &c. rectified to your Latitude; Turn the Globe till the Index of the Hour-circle come to the given hour; and bring the Quadrant of Altitude to the place of the Sun; ſo ſhall the number of degrees contained between the Eaſt point of the Horizon, and the degree cut by the Quadrant of Alritude on the Horizon be the number of degrees of the Suns Azimuth, at that time.

Example.

May 10. at 53. minutes paſt 8 a clock in the Morning I would know the Azimuth of the Sun: Therefore the Globe being firſt rectified) I turn about the Globe till the Index of the Hour-circle point to 53 min. paſt 8 a clock, or which is all one, within half a quarter of an hour of 9; then I move the Quadrant of Altitude to the degree the Sun is in that day, and there let it remain till I ſee how many degrees is contained between the North point and the Quadrant, of Altitude, which in this Example is 118 deg. 25 min. And becauſe this diſtance from the North exceeds 90 degrees, therefore I ſubſtract 90 deg. from the whole, and the remains is 28 deg. 25 min. for the Azimuthal diſtance of the Sun from the Eaſt point towards the South. But if it had wanted of 90 degrees from the North point, then ſhould the complement of 90 have been the Azimuthal diſtance of the Sun from the Eaſt point.

PROB.

PROB. XXIII.

The Place of the Sun and hour of the day given, to find the Almicantar of the Sun.

THe finding the Almicantar of the Sun is upon the matter the ſame with the Altitude of the Sun: only with this diſtinction; The Almicantars are circles parallel to the Horizon, deſcribed by the degree of the Quadrant of Altitude upon the Zenith as its center, by turning the Quadrant round about the Globe till it come again to its firſt place: But the Altitude is an arch of the Vertical circle, comprehended between the Horizon and any point of the Globe aſſigned. Their agreement conſiſts in this; When the Sun or any Star hath any known Almicantar, they are ſaid to have the ſame number of degrees of Altitude; as if the Sun be in the 20th Almicantar; he hath 20 degrees of Altitude; if in the 30th Almicantar, he hath 30 degrees of Altitude, &c. Now becauſe the Operation is the ſame for finding the Altitude and Almicantar, I ſhall refer you to the 11th Probleme; which ſhews you how to find the Altitude or Height; and by conſequence the Almicantar.

PROB. XXIV.

The place of the Sun given, to find what hour it comes to the Eaſt, or Weſt; and what Almicantar it then ſhall have.

THe Globe, Quadrant, and Hour-Index rectified. Bring the Quadrant of Altitude to the Eaſt point in the Horizon, if you would know what hour it comes to the Eaſt; or to the Weſt point, if you would know what hour it comes to the Weſt; Then turn about the Globe till the place of the Sun come to the Quadrant of Altitude; and the Index of the Hour-circle ſhall point at the hour of the day: which on the day aforeſaid will be 7 hor. 7 min. in the morning that the Sun commeth to the Eaſt, and 4 hor. 53 min. after noon that the Sun commeth to the Weſt. And if you then count the number of degrees from

the Horizon upwards on the Quadrant of Altitude, it will shew you the Almicantar of the Sun for that time; which will both morning and evening be 25 deg. 30 min. as was taught by the last Probleme.

PROB. XXV.

To know at any time what a clock it is in any other part of the Earth.

THe difference of Time is reckoned by the access and progress of the Sun: for the Sun gradually circumvolving the Earth in 24 hours, doth by reason of the Earths rotundity enlighten but half of it at the same moment of Time; as shall be shewed hereafter: so that hereby it comes to pass, that when with us here in *England* it is 6 a clock in the morning, with those that have 90 degrees of Longitude to the Westward of us, it is yet midnight: with those that have 180 degrees of Longitude from us it is evening; and with those that have 90 degrees of Longitude to the Eastwards, it is noon. So that those to the Eastward have their day begin sooner than ours: But to the Westward their day begins after ours. Therefore that you may know what hour it is in any Place of the Earth, of what distance soever it be, you must first Bring the place of your own Habitation to the Meridian, and the Index of the Hour-circle to 12 on the Hour circle; Then bring the other Place to the Meridian, and the arch of the Hour circle comprehended between the hour 12 and the Index, is the difference in Time between the two Places.

Example.

London in *England*, and *Surat* in the *East Indies*: First I bring *London* to the Meridian, and turn the Index of the Hour-circle to 12; then I turn the Globe Westward, because *London* is Westward of *Surat*, till *Surat* come to the Meridian; and see at what Hour the Index of the Hour circle points, which in this Example is 5 hor. 54 minutes: And because *Surat* lies to the Eastwards of us so many degrees, therefore as was said before, their

their Day begins ſo much before ours: So that when here at *London* it is 6. a clock in the Morning at *Surat* it will be 11. a clock 54. minutes; when with us it is 12. a clock, with them it will be 5. a clock 54. minutes after noon.

If you would know the difference of Time between *London* and *Jamaica*; Working as before, you may find 5. hor. 15. min. But *Jamaica* is to the Weſt of *London*; therefore their Day begins 5. hor. 15. min. after ours: ſo that when with us it is Noon, with them it will be but three quarters of an hour paſt 6 a clock in the Morning: and when with them it is Noon, with us it will be one quarter paſt 5. a clock after Noon, &c.

Or you may yet otherwiſe know the difference of Time, if you divide the number of degrees of the Equinoctial that paſs through the Meridian while the Globe is moved from the firſt Place to the ſecond, by 15. ſo ſhall the product give you the difference of hours and minutes between the two Places: as you will find if you try either of theſe Examples, or any other.

PROB. XXVI.

To find the Right Aſcenſion of the Sun, or Stars.

THe Right Aſcenſion of any point on the Globe is found by bringing the point propoſed to the Meridian, and counting the number of degrees comprehended between the Vernal Colure and the Meridian.

Example, for the Sun.

June 1. I would know the Right Aſcenſion of the Sun: His place (found as by the third Probleme) is *Gemini* 20. Therefore I bring *Gemini* 20 to the Meridian; and then the Meridian cuts the Equinoctial in 79 deg. 15 min. accounted from the Vernal point *Aries*: Therefore I ſay the Right Aſcenſion of the Sun *June* 1. is 79 deg. 15 min.

Example, for a Star.

I take *Capella*, alias *Hircus*, the *Goat* on *Auriga*'s ſholder, and

and bring it to the Meridian; and find the Meridian cut the Equinoctial (counting as before from the *Vernal* point ♈) in 73 degrees 58 minutes: Therefore I say, the Right Ascension of *Hircus* is 73 degrees 58. min. Do the like for any other point of the Globe proposed.

PROB. XXVII.

To find the Declination of the Sun and Stars.

THe Declination of any point on the Globe is found by bringing the point proposed to the Meridian, and counting the number of degrees comprehended on the Meridian between the Equinoctial and the point proposed: and bears its Denomination of North or South, according as it is scituate on the North or South side the Equinoctial.

Example, for the Sun.

June 1. I would know the Declination of the Sun. His place found, as before, is *Gemini* 20 Therefore I bring ♊ 20 to the Meridian; and find 23 deg. 8 min. comprehended on the Meridian between the Equinoctial and ♊ 20. and because *Gemini* is on the North side the Equinoctial; therefore I say *June* 1. The Sun hath North Declination 23 deg. 8 min.

Example, for a Star.

I take *Hircus* aforesaid, and bring it to the Meridian, and find 45 deg. 40 min. comprehended on the Meridian between the Equinoctial and the Star *Hircus*. And because *Hircus* is on the North side the Equinoctial; Therefore I say, *Hircus* hath North Declination 45 degrees 40 min. Do the like for any other point on the Globe proposed.

But note. The Right Ascension and Declination of the Sun alters dayly; for in twelve Moneths he runs through every degree of Right Ascension, and in three moneths to his greatest Declination: But the Right Ascension and Declination of the Stars is scarce perceiveable for some Years: Yet have they also an alteration of Right Ascension and Declination: For, those Stars that

that have but few degrees of Right Ascension, will in process of Time have many; and those Stars between the Tropick that have North Declination, will in length of Time have South Declination; and the contrary (as shall be more fully shewed hereafter:) For, the Stars moving upon the Poles of the Ecliptick go forwards in Longitude one whole Degree in 70½ Years (as hath been shewed before, *Book* 1. *Chap.* 3. *Sect.* 3.) and so alter both their Right Ascension, and Declination; as may be seen by this following Table of Right Ascensions and Declinations of 100. of the most eminent fixed Stars; Calculated by *Tycho Brahe*, for the Years 1600. and 1700. which I have inserted; partly, because by it you may see the difference of their Right Ascensions and Declinations in 70½ Years; and partly to Accomodate those that may have occasion to know their Right Ascensions and Declinations neerer than the Globe can shew them.

A Table of the Right Ascensions and Declinations of 100. *Select fixed Stars; Calculated by* Tycho Brahe, *for the Years* 1600, *and* 1700. *As also their Difference of Right Ascensions and Declinations, in* 70. *Years.*

Names of the Stars.	1600 R. Asc.	1600 Declin.		Differentia. R. A.	Differentia. Decl.	1670 R. Asc.	1670 Declin.	
Scedir, in Cassiopeæ.	4 36	54 21	N	1 22	34 S	5 58	54 55	
The Pole Star.	5 47	87 9	N	3 59	34 S	9 46	87 43½	
Southern in the Wales tail.	5 51	20 12	S	1 17	34 N	7 8	19 38	
Cassiopeæ's Belly.	8 21	58 33	N	1 27	34 S	9 48	59 7	
Girdle Andromeda.	11 50	33 32	N	1 23	33 S	13 13	34 5	
Knee of Cassiopeæ.	15 3	58 7	N	1 35	33 S	16 38	58 40	
1. in ♈ horn.	22 56	17 19	N	1 23	31 S	24 19	17 50	
Whales belly.	22 59	12 16	S	1 15	31 N	24 14	11 45	
2. in ♈ horn.	23 10	18 50	N	1 22	31 S	24 32	19 31	
South foot of Andromeda.	24 55	40 23	N	1 29	30 S	26 24	40 52	

Names of the Stars.	1600 R.	Asc.	Declin.		*Differentia* R. A.	Decl.		1700 R.	Asc.	Declin.	
In the Knot in the line ♓.	25	22 0	50	N	1 18	30	S	26	40 1	20	
✱ *Star in* ♈ *head*	26	23 21	33	N	1 25	30	S	27	38 22	3	
✱ *In the whales jaw.*	40	25 2	29	N	1 15	25	S	41	40 2	54	
Caput Meduſæ.	41	38 39	22	N	1 37	25	S	42	15 39	47	
✱ *In Perſeus ſide.*	44	24 8	22	N	1 28	21	S	45	30 48	43	
✱ *In the* Pleiades.	50	57 22	49	N	1 29	21	S	52	26 23	10	
In the Noſtrils of ♉.	59	16 14	37	N	1 25	17	S	60	41 14	54	
North Ey of ♉.	61	21 18	14	N	1 24	17	S	62	45 18	31	
Aldebaran.	63	16½ 15	38	N	1 26½	15	S	64	43 15	53	
Hircus, Capella.	71	49 45	30	N	1 49	10	S	73	38 45	40	
✱ *Orions foot,* Rigel.	73	51½ 8	43	S	1 15½	9½	S	75	7 8	33	
North Horn ♉.	75	16 28	12	N	1 37	8	S	76	53 28	20	
Orions left ſhoulder.	75	58 5	55	N	1 19	8	S	77	17 6	3	
Belly of the Hare.	77	43 21	6	S	1 57	7	N	78	53 20	59	
1 *In Orions Girdle.*	77	58 0	39	S	1 17	7	N	79	15 0	32	
Uppermoſt in Orions face.	78	21 9	36	N	1 22	7	S	79	41 0	43	
South Horn ♉.	78	26 20	51	N	1 31	7	S	79	57 20	58	
2 *In Orion: Girdle.*	79	1 1	30	S	1 17	6	N	80	18 1	24	
Laſt in Orions Girdle.	80	10 2	12	S	1 16	5	N	81	26 2	7	
Aurigas right Shoulder.	82	40 44	50	N	1 55	4	S	84	35 44	54	
Orions right Shoulder.	83	26 7	16	N	1 22	4	S	84	48 7	20	
✱ *Foot* it.	93	38 16	40	N	1 28	2	N	95	6 16	38	
Great Dog Sirius. (*Twin*	96	53 16	11	S	1 7	4	S	98	0 16	15	
Head of Caſtor, the firſt	107	9 32	41	N	1 44	11	N	108	53 32	30	
The little Dog, Procyon.	109	37 6	12	N	1 20	12	N	110	57 6	0	
Head Polluxe, ſecond Twin	110	13 28	55	N	1 34	12	N	111	47 28	43	
✱ *In the Stern of the Ship*	117	39 23	11	S	1 4	15	S	118	43 23	26	
Præſepe ♋	124	20 21	2	N	1 28	19	N	125	48 20	43	
Northern Aſſe ♋.	124	58 22	51	N	1 30	20	N	126	28 22	31	
Southern Aſſe ♋.	125	2 19	35	N	1 27	20	N	126	54 19	15	
The Heart of Hydra.	137	16	57	S	1 15	25	S	138	16 7	22	
South of 3. *in neck* ♌	146	22 18	42	N	1 28	28	N	147	50 18	14	
Lions Heart, Baſiliſcus.	146	45½ 13	53½	N	1 53½	28½	N	148	8 13	25	
North of 3. *in neck* ♌	148	33 25	23	N	1 23	29	N	150	1 24	54	
Middle of 3. *in neck* ♌	149	25½ 21	50	N	1 50	29	N	150	51 21	21	

Name

Names of the Stars.	1600 R.	Asc.	Declin.		Differentia. R. A	Decl.	1700 R.	Asc.	Declin.	
First lowest in ☐ Vrsa Maj.	159	12	58	31 N	1 37	32 N	160	49	57	59 N
First upper in ☐ Dubbe	159	37	63	54 N	1 41	32 N	161	18	63	22 N
* back ♌.	163	10	22	43 N	1 27	34 N	164	37	22	9 N
Lions tail. (Major	172	9	16	49 N	1 19	34 N	173	28	16	15 N
following lowest in ☐ Ursa	173	3	55	57 N	1 23	34 N	174	26	55	23 N
Uppermost following in ☐.	178	50	59	15 N	1 20	34 N	180	10	58	41 N
Girdle ♍.	188	53	5	37 N	1 18	34 N	190	11	5	3 N
Rump Ursa Major, Aliot.	189	1	58	10 N	1 19	33 N	190	10	57	37 N
Vindemiatrix, ♍.	190	36	13	8 N	1 17	33 N	191	53	12	35 N
Spica ♍.	196	49	1	S	1 19½	32½ S	197	23½	9	31 S
Middle tail Ursa Major.	196	54	57	3 N	1 3	32 N	197	57	56	31 N
End tail Ursa Major.	202	54	51	22 N	1 2	31 N	203	56	50	51 N
Arcturus.	209	23½	21	18½ N	1 11	29 N	210	34½	20	49 N
Left shelder of Bootes.	214	2	40	3 N	1 2	27 N	215	4	39	36 N
South Scale ♎.	217	14½	14	18 S	1 23	27 S	218	37½	14	45 S
North Scale ♎.	223	54	7	50 S	1 21½	24 S	225	16	8	14 S
* Northern Crown.	229	26	28	6 N	1 5	21 N	230	31	27	45 N
* Serpents neck.	231	12	7	46 N	1 15	21 N	232	27	7	25 N
Northern of 3. * in front	235	34	13	38 S	1 28	19 S	237	2	18	57 S
Left hand Ophiucus (♏	238	25	2	37 S	1 23	18 S	239	48	2	55 S
Heart ♏. Antares,	241	18	5	26 S	1 32	16 S	242	50	25	42 S
Right Shelder. Hercules.	243	39	22	27 N	1 5	15 N	244	20	22	12 N
Left knee of Ophiucus.	243	49	9	39 S	1 23	15 S	245	12	9	54 S
Right knee of Ophiucus.	251	50	15	7 S	0 50	10 S	252	40	15	17 S
Head of Hercules.	254	6	14	55 N	1 8	8 N	255	14	14	47 N
Left Shelder of Hercules.	254	40	25	22 N	0 52	8 N	255	32	25	14 N
Head of Ophiucus.	259	5	12	56 N	1 11	7 N	260	16	12	49 N
Right Shelder of Ophiucus.	260	56	4	49 N	1 13	5 N	262	9	4	44 N
* head of the Dragon.	266	52	51	37 N	0 35	2 N	267	27	51	35 N
* Lyræ.	275	52	38	28 N	0 50	4 S	276	42	38	32 N
Most Eastern in Head ♐.	281	32	21	35 S	1 31	8 N	283	3	21	27 S
Vultures tail.	281	47	13	20 N	1 13	8 S	283	0	13	28 N
In the Swans Beak.	288	40	27	10 N	1 1	11 S	289	41	27	21 N
* in Vulture.	292	49	7	54 N	1 17	13 S	294	6	8	7 N
In the Swans North wing	293	10	44	12 N	0 48	14 N	293	58	44	26 N

Names of the Stars.	1600 R	Asc	Declin.			Differentia R. A.	Decl.		1670 R.	Asc.	Declin
Upper horn ♉.	289	57	13	40	S	1 25	16	N	300	22	13 24
Lower horn ♉.	299	39	15	57	S	1 27	17	N	301	6	15 40
In the Swans breast.	302	1½	39	1	N	0 53½	18	S	302	55	39 19
Left hand of ♒.	306	32	10	53	S	1 16	19	N	307	48	10 34
Swans Tail.	306	57½	43	53½	N	0 51½	20½	S	307	49	44 14
In the Swans South wing.	307	31	32	30	N	1 0	21	S	308	31	32 51
Left Sholder ♒.	317	37	7	15	S	1 21	26	N	318	58	6 49
1. *In tail* ♉.	319	28	18	21	S	1 26	26	N	320	54	17 55
In Cepheus Girdle.	320	46	68	50	N	0 22	26	S	321	8	69 16
In Pegasus mouth.	321	10	8	5	N	1 18	26	S	322	28	8 31
2 *In tail* ♉.	321	16	17	51	S	1 25	27	N	322	41	17 24
Right Sholder of ♒.	326	19	2	13	S	1 20	29	N	327	39	1 44
Fomahant, ♒.	338	46	31	39	S	1 25	31	N	340	11	31 8
Scheat, *Pegasus*	241	9	25	56	N	1 12	32	S	342	11	26 28
Marchab, *Pegasus.*	341	15	13	5	N	1 15	32	S	342	30	13 37
Mouth of Southern fish.	344	9	1	7	N	1 17	33	S	345	26	1 40
Head of Andromeda.	356	59	26	54	N	1 17	34	S	358	16	27 28
* *Cassiopeæ's chair.*	357	5	56	58	N	1 15	34	S	358	20	57 32
End of Pegasus wing.	358	14	12	58	N	1 16	34	S	359	30	13 32
Northern the whales tail.	359	49	11	1	S	1 18	34	S	1	7	10 27

The Use of this Table.

The first Cullumne on the left hand is the names of the Stars. The Second Cullumne shews the degrees and minutes of Right Ascension for the Year 1600. The third the Declination for the same Year. The fourth shews whether the Declination be North or South; N stands for North, S for South. The fifth shews the difference in degrees and minutes of Right Ascension of the Stars, between the Years 1600. and 1670. The sixth shews the Difference of Declination; and whether it be North, or South. The seventh shews the Right Ascension in degrees and minutes for the Year 1670. The eighth shews the Declination in degrees and minutes for the same Year.

By this Table you may perceive the fixed Stars increase in Right Ascension, till they come to the Vernal Colure; from whence

whence the number of their Right Ascension is reckoned: and by the Cullumne of their Difference of Right Ascension, you may see how much they increase in 70. Years. And if you would know how much they increase for any other number of Years, you must find what proportion they have to 70, and the same proportion the Difference of the Right Ascension of the Stars will have to the Difference in the Table.

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Example.

I would know the Difference of Right Ascension the Pole-Star will have in 35. Years. I find in the fifth Cullumne the Difference of Right Ascension of the Pole Star to be 3. degrees 59. minutes, Therefore by the Rule of Proportion, I say, If 70. Years give 3. degrees 59. minutes, 35. Years shall give 1. degree 59½ minutes, and so proportionably for any other number of Years.

Though this Rule serves for finding the Difference of Right Ascension of any Star; Yet it will not serve for finding the Difference of any Stars Declination. For the Stars on the North side the Equinoctial between the *Hyemnal* and *Solstitial* Colures, and on the South side the Equinoctial between the *Sristicial* and *Hyemnal* Colures increase in Declination. But the Stars on the South side the Equinoctial between the *Hyemnal* and *Solsticial* Colures, and on the North side the Equinoctial between the *Solsticial* and *Hyemnal* Colures, Decrease in Declination: as you may yet more plainly see by the Globe if you bring 66½ degrees of the Meridian to the North side of the Horizon, and screw the Quadrant of Altitude to 66½ degrees in the Zenith, and Declination of the Pole of the Ecliptick; and bring the *Hyemnal* Colure to the Meridian, for so shall the Pole of the Ecliptick be joyned with the center of the Quadrant of Altitude, and the Ecliptick with the Horizon; and all the Circles that the several degrees on the Quadrant make in a Revolution from West to East upon the Poles of the Ecliptick, represent the great Revolution of every Star that each degree on the Quadrant cuts. And thus demonstratively will be represented the progress of the fixed Stars through every degree of Longitude, and by consequence the alteration of their Right Ascension, and Declination. For, Imagining that degree of the Quadrant

drant of Altitude to be the Star, which just reaches the Star; you may by turning about the Quadrant, see how Obliquely the Star (or the degree representing the Star) either moves about, or cuts the Equinoctial, and all Circles parallel to the Equinoctial; and thereby observe it sometimes to incline in motion to, and other times to decline in motion from the Equinoctial. But how long time it will be ere the Star inclines to, or declines from the Equinoctial, you may know by finding the distance of Longitude in degrees it hath from either the *Solstitial*, or *Hyemal* Colure; and with respecting the foregoing Rules in its Position; you may by the Table in Book 1. Chap. 3. Sect. 3. satisfie your self.

Example.

The most Northerly Star in the *Girdle of Orion* doth yet decrease in Declination. But I would know how long it shall decrease; Therefore by the 32. Probleme, I find the Longitude of that Star to be for the Year 1670. 77. degrees 51. minutes, which subducted out of 90, (the distance of the Solsticial Colure from the Equinoctial,) leaves 12. 9. for the distance of that Star from the Solstitial Colure. Therefore by the Table aforesaid, I find what number of Years answers to the motion of 12. degrees 9. minutes. And because I cannot find exactly the same number of degrees and minutes in the Table, I take the number neerest to it; which is 14. degrees 10. minutes, and that is the motion of the Ecliptick in 1000. Years. But because this 14. degrees 10. minutes is 2. degrees 1. minute too much, I seek 2. degrees 1. minute in the Table, and the number of Years against it I would subduct from the number of Years against 14. deg. 10. min. and the remainder would be the number of Years required: But neither can I find 2. degrees 1. minute, therefore I must take the number of degrees and minutes neerest to it, which is 2. deg. 50. min. and that yeelds 200. Years; which subducted out of 1000. leaves 800. Years. But because this is also too much by the motion of 49. minutes, Therefore I seek for 49. minutes in the Table, and subduct the number of Years against it from 800. and the remainder would be the number of Years required. But neither is 49. min. in the Table, Therefore I take the neerest to it, which is 51. minutes, and that yeelds 60. Years; which subducted out of 800. leaves 740. But this is likewise too much by the

the motion of two min. Therefore I ſeek 2 min. in the Table, but cannot find it neerer then $2\frac{1}{2}$, and againſt it I find 3. Years, which 3. Years I ſubduct out of 740. and the Remainder is 737. the number in Years required. You may if you pleaſe for exactneſs, ſubduct for the $\frac{1}{2}$ min. 8. Moneths; ſo have you 736. Years 4. Moneths, for the Time that the moſt Northerly Star in the *Girdle of Orion* will decreaſe in Declination, after the Year 1670. which will be till *An. Dom.* 2406. after which time it will increaſe in Declination for 12706. Years together, till it come to have 47. degrees 8 min of Declination: at which time it will be in or very neer the place of the moſt Southerly Star of the *Southern Crown*; and that Star in its place.

And thus the Pole Star is now found to increaſe in Declination, and will yet this 421. Years: after which time it will decreaſe in Declination for 12706 Years together, till it come to be within 42. degrees 42. minutes of the Equinoctial, in the void ſpace now between *Draco* and *Lyra*; at which time *Lyra* will be almoſt as neer the Pole, as the Pole Star now is; and then the moſt proper to be the Northern Pole Star: And the laſt Star in the *Stalk of the Doves mouth* will be then very neer the Southern Pole, and therefore moſt fit to be the Southern Pole-Star.

PROB. XXVIII.

The Place of the Sun or any Star given, to find the Right Deſcenſion, and the Oblique Aſcenſion, and the Oblique Deſcenſion in any given Latitude.

THe Globe Rectified, bring the Place of the Sun or Star to the Meridian under the Horizon, and the degree of the Equator that comes to the Meridian with it is the Degree of Right Deſcenſion If the Sun or Star will reach no part of the Meridian under the Horizon they have no Right Deſcenſion.

For the Oblique Aſcenſion.

Bring the Place of the Sun or the Star to the Eaſt ſide the Horizon, and the degree of the Equator cut by the Horizon, is the Degree of Oblique Aſcenſion of the Sun or Star. For

For the Oblique Deſcenſion.

Bring the Place of the Sun or Star to the Weſt ſide the Horizon, and the degree of the Equinoctial cut by the Horizon is the Degree of Oblique Deſcenſion. They need no Example.

PROB. XXIX.

Any Place on the Tereſtrial Globe being given, to find its Antipodes.

BRing the given Place to the Meridian, ſo may you (as by the firſt Probleme) ſee its Longitude and Latitude; then turn about the Globe till 180. degrees of the Equator paſs through the Meridian; and keeping the Globe to this Poſition, number on the Meridian 180. degrees from the Latitude of the given Place: and the point juſt under that degree is the Antipodes.

Example.

I would find the Antipodes of *Cuida Real*, an Inland Town of the *Weſt Indies*, which lies upon the River *Parana*, an Arm of *Rio de la Plata*: Therefore I bring *Cuida Real* to the Meridian, and find (as by the firſt Probleme) its Latitude 23. 50. South; and its Longitude 333. degrees: Then I turn about the Globe till 180. degrees of the Equator paſs through the Meridian; and keeping the Globe to that poſition, I number ſo many degrees North Latitude as *Parana* hath South, viz. 23. 50. and juſt under that degree I find *Lamoo*, a Town lying upon the Coaſt of *China*, in the Province of *Quincij*: Therefore I ſay *Lamoo* is juſt the Antipodes of *Cuida Real*.

Another way.

Bring the given Place to the North or South point of the Horizon, and the point of the Globe denoted by the oppoſite point of the Horizon is the Antipodes of the given Place.

PROB.

PROB. XXX.

To find the Perecij of any given Place, by the Terreſtrial Globe.

BRing your Place to that ſide the Meridian which is in the South notch of the Horizon, and follow the Parallel of that Place on the Globe till you come to that ſide the Meridian which is in the Northern notch of the Horizon; and that is the *Perecij* of your Place.

PROB. XXXI.

To find the Antecij of any given Place, upon the Terreſtrial Globe.

BRing your Place to the Meridian, and find its Latitude by the firſt Probleme; If it have North Latitude, count the ſame number of degrees on the Meridian from the Equator Southwards; But if it have South Latitude, count the ſame number of degrees from the Equator Northwards: and the point of the Globe directly under that number of degrees is the *Antecij* of your Place.

PROB. XXXII.

To find the Longitude and Latitude of the Stars by the Cæleſtial Globe.

THe Quadrant of Altitude will reach but 90. degrees, as was ſaid Prob. 9. Therefore if the Star you enquire after be on the North ſide the Ecliptick; Elevate the North Pole 66½ degrees above the North ſide the Horizon: If on the South ſide the Ecliptick you muſt elevate the South Pole 66½ degrees above the South ſide the Horizon: Then bring the *Solſticial Colure* to the Meridian on the North ſide the Horizon, and ſcrew the Quadrant of Altitude to the *Zenith*, which will be in 23. deg. 30. min. from the Pole of the World: So ſhall the Ecliptick ly in the Horizon, and the Pole of the Ecliptick alſo ly under the Center of the Quadrant of Altitude (as was

ſhewed Prob. 27.) Now to find the Longitude of any Star, do thus, Turn the Quadrant of Altitude about till the graduated edge of it ly on the Star; and the degree in the Ecliptick that the Quadrant touches is the Longitude of that Star.

Example, for a Star on the North ſide the Ecliptick.

I would know the Longitude of *Marchab*, a bright Star in the wing of *Pegaſus*: I find it on the North ſide the Ecliptick; Therefore I elevate the North Pole, and placing ♋ on the North ſide the Meridian, I ſcrew the Quadrant of Altitude to the Zenith, as aforeſaid, Then laying the edge of the Quadrant of Altitude upon that Star, I find that the end of it reaches in the Ecliptick to ♐ 18. 56. Therefore I ſay, the Longitude of *Marchab* is ♐. 18. 56.

For the Latitude of a Star.

The Degree of the Quadrant of Altitude that touches the Star is the Latitude of the Star.

Example,

The Globe and Quadrant poſited as before, I find 19. degrees 26. minutes (accounted upwards on the Quadrant) to touch *Marchab* aforeſaid: Therefore I ſay, the Latitude of *Marchab* is 19. deg. 26. min.

And thus by elevating the South Pole and placing the Globe and Quadrant of Altitude as aforeſaid, I ſhall find *Canicula* have 15. degrees 57. min. South Latitude, and 21. degrees 18. min. in ♋, Longitude.

PROB. XXXIII.

To find the Diſtance between any two Places, on the Terreſtrial Globe.

THis may be performed either with the Quadrant of Altitude, or with a paire of Compaſſes: with the Quadrant of Altitude, thus: Lay the lower end thereof to one Place, and ſee what degree reaches the other Place, for that

that is the number of degrees between the two Places. If you multiply that number of degrees by 60 the product ſhall be the number of Engliſh Miles between the two places.

Example.

I would know the diſtance between *London* and the moſt Eaſterly point of *Jamaica*; I lay the lower end of the Quadrant of Altitude to *Jamaica*, and extending the other end towards *London* I find $68\frac{1}{2}$ deg. comprehended between them; Therefore I ſay $68\frac{1}{2}$ is the number of degrees comprehended between *London* and *Jamaica*.

If you would find the diſtance between them with your Compaſſes, you muſt pitch one foot of your Compaſſes in the Eaſt point of *Jamaica*, and open your Compaſſes till the other foot reach *London*; and keeping your Compaſſes at that diſtance apply the feet to the Equinoctial line, and you will find $68\frac{1}{2}$. degrees comprehended between them, as before.

If you multiply $68\frac{1}{2}$. by 60 it gives 4114. *Engliſh* miles.
If you multiply it by 20 it gives 1370. *Engliſh* Leagues.
If you multiply it by $17\frac{1}{2}$. it gives 1199. *Spaniſh* Leagues.
If you multiply it by 15, it gives 1054. *Dutch* Leagues.

PROB. XXXIV.

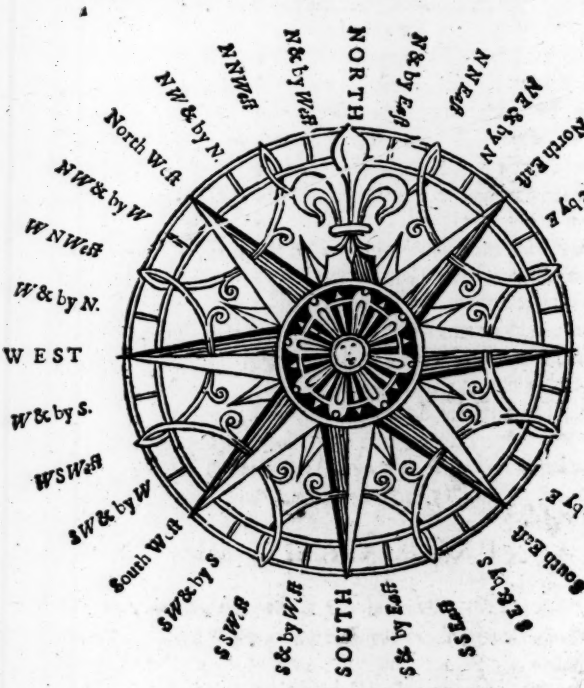
To find by the Terreſtrial Globe upon what point of the Compaſs any two Places are ſcituate one from another.

FInd the two Places on the Terreſtrial Globe, and ſee what Rumb paſſes through them; for that is the point of the Compaſs they bear upon.

Example.

Briſtol and *Bermudas* are the Places. I examine what Rumb paſſes through them both: and becauſe I find no Rumb to paſs immediately through them both, Therefore I take that Rumb which runs moſt parallel to both the Places; which in this Example is the tenth Rumb counted from the North towards the left hand; and is called as you may ſee by this following

Figure *West South West*; Therefore I say *Bermudos* lies situate from *Bristol West South West*; and by contraries *Bristol* lies scituate from *Bermudos East North East*.



PROB. XXXV.

To find by the Celestial Globe the Cosmical Rising *and* Setting *of the Stars.*

WHen any Star Rises with the Sun, it is said to Rise *Cosmically.*

And when any Star Sets when the Sun Rises, it is said to Set *Cosmically*

To find these, Rectifie the Globe to the Latitude of your place,

place, and bring the place of the Sun to the East side the Horizon; and the Stars then cut by the Eastern Semi-circle of the Horizon, Rise Cosmically: and those Stars cut by the Western Semi-circle of the Horizon, Set Cosmically.

Example.

Novemb. 9. I would know what Stars Rise and Set Cosmically, here at *London* The Suns place found, as by the third Probleme, is ♏. 27. Therefore I bring ♏. 27 to the East side the Horizon, and in the Eastern Semi-circle I find rising with the Sun the right wing of *Cygnus*, the Star in the end of *Aquila*'s tail, *Serpentarius* and *Centaurus*: Therefore these Constellations are said to rise Cosmically. In the Western Semicircle of the Horizon I find Setting *Andromeda*, the *Triangle*, *Taurus*, *Orion*, *Canis major*, and *Argo Navis*; Therefore I say, these Constellations Set Cosmically.

PROB. XXXVI.

To find by the Celestial Globe the Acronical *Rising and Setting of the Stars.*

THe Stars that Rise when the Sun Sets, are said to Rise *Acronically*. And

The Stars that Set with the Sun, are said to Set *Acronically*.

To find these, Rectifie the Globe to the Latitude of your Place, and bring the place of the Sun to the West side the Horizon; and the Stars then cut by the Eastern Semicircle of the Horizon, Rise *Acronically*: And those Stars cut by the Western Semi-circle of the Horizon, Set *Acronically*.

Example.

November 9. I would know what Stars Rise and Set *Acronically* here at *London*. The Suns place as before, is ♏. 27. Therefore I bring *Scorpio* 27 to the West side the Horizon; and in the Eastern Semi-circle I find Rising the Southern *Fish*, *Fomahant*, *Cetus*, *Taurus*, *Auriga*, and the Feather in *Castor*'s Cap. Therefore these Constellations are said to Rise Acronically. In

the Western Semi-circle of the Horizon I find Setting the *Lyons tail*, *Virgo*, *Scorpio*, and *Sagittarius*, Therefore I say these Constellations Set *Acronically*.

PROB. XXXVII.

To find by the Celestial Globe the Heliacal Rising *and* Setting *of the Stars.*

WHen a Star formerly in the Suns beams gets out of the Suns beams, it is said to *Rise Heliacally*. And

When a Star formerly out of the Suns beams gets into the Suns beams, it is said to *Set Heliacally*.

A Star is said to be in the Sun beams when it is made inconspicuous by reason of its neerness to the Suns Light. The bigger Stars are discernable more neer the Suns Light, than the Lesser are; For, Stars of the first Magnitude may (according to the received Rules of ancient Authors) be seen when the Sun is but 12 degrees below the Horizon; but Stars of the Second Magnitude cannot be seen unless the Sun be 13 degrees below the Horizon: Stars of the third Magnitude require the Sun to be 14 degrees below the Horizon ere they can be seen; of the fourth Magnitude 15 degrees, of the fifth Magnitude 16 degrees, of the sixth Magnitude 17 degrees; the Nebulous ones 18 degrees. Yet this Rule is not so certain but that either clear or cloudy weather may alter it. Read more of this subject in Mr *Palmer* on the *Planisphere*. Book 4. ch. 20.

Now to find the Time that any Star shall Rise Heliacally, do thus; Rectifie the Globe and Quadrant of Altitude to your Latitude, then bring the given Star to the East side the Horizon, and turn the Quadrant of Altitude into the West side, and see what degree of the Ecliptick is elevated so many degrees above the Horizon as the magnitude of the Star you enquire after requires, according to the foregoing Rules; for the opposite degree of the Ecliptick is the degree the Sun shall be in when that Star Rises Heliacally. Having the degree of the Ecliptick the Sun is in, you may find the Day of the Moneth by the fourth Problem.

Exam-

Example.

I would know when *Cor Leonis* ſhall Riſe *Helically* here at *London*: Therefore I Rectifie the Globe and Quadrant of Altitude for *London*, and bring *Cor Leonis* to the Eaſt ſide the Horizon, and turn the Quadrant of Altitude into the Weſt; and becauſe *Cor Leonis* is a Star of the firſt Magnitude, therefore I ſee what degree of the Ecliptick is elevated in the Weſt ſide the Horizon 12. degrees on the Quadrant of Altitude and find *Piſces* 9 deg. Now the degree of the Ecliptick oppoſite to ♓ 9. is ♍ 9. Therefore I ſay when the Sun comes to ♍ 9. degrees (which by the 4th Probleme I find is *Auguſt.* 23.) *Cor Leonis* ſhall Riſe *Helically*.

For the Helical Setting.

The Globe &c. Rectified, as before: Bring the Star to the Weſt ſide the Horizon, then ſee what degree of the Ecliptick is elevated on the Quadrant of Altitude ſo many degrees as the Stars Magnitude requires; for when the Sun comes to the oppoſite degree of the Ecliptick that Star ſhall ſet *Heliacally*.

Example.

I would know when *Bilanx* a Star in the *Beam* of the *Scales* will ſet *Heliacally* here at *London*. The Globe and Quadrant Rectified, I bring *Bilanx* to the Weſt ſide the Horizon, and turn the Quadrant of Altitude into the Eaſt; Then I examine what degree of the Ecliptick is elevated 13. degrees of the Quadrant of Altitude (becauſe *Bilanx* is a Star of the ſecond Magnitude) and find ♉ $4\frac{1}{2}$ oppoſite to ♉ $4\frac{1}{2}$ is *Scorpio* $4\frac{1}{2}$, therefore I ſay, When the Sun comes to *Scorpio* $4\frac{1}{2}$ (which by Prob. 4. will be *October* 18) *Bilanx* ſhall ſet *Heliacally*.

PROB. XXXVIII.

To find the Diurnal and Nocturnal Arch of the Sun, or Stars, in any given Latitude.

THe Semi-Diurnal Arch is the number of degrees of the Equator that paſſes through the Meridian whiles the Sun or any

any Star is aſcending above the Eaſt ſide the Horizon to the Meridian. To know the number of degrees it contains, Rectifie the Globe to the given Latitude, and bring the Place of the Sun or Star to the Eaſt ſide the Horizon, and note what number of degrees of the Equinoctial is then cut by the Meridian: Then remove the Place of the Sun or Star to the Meridian, and ſee again what number of degrees of the Equinoctial is then cut by the Meridian, and ſubſtract the former from the latter, and the remainder ſhall be the number of degrees of the Sun or Stars Semi Diurnal Arch. But Note, if the Equinoctial point ♈ paſs through the Meridian while the Sun or Star is turned from the Eaſt ſide the Horizon to the Meridian, then you muſt ſubſtract the number of degrees of the Equinoctial cut by the Meridian when the Sun or Star is at the Eaſt ſide the Horizon from 360. degrees, and to the remainder ad the number of degrees of the Equinoctial that comes to the Meridian with the Place of the Sun or Star, and the Sum of them both is the number of degrees of the Sun or Stars Semi-diurnal Arch; which being doubled is the number of degrees of the whole Diurnal Arch: and which being ſubſtracted from 360. gives the Nocturnal Arch.

Example, of the Sun.

Having Rectified the Globe, I would *May* 10. know the Diurnal Arch of the Sun: His Place found by *Prob.* 3. is ♉ 29. Therefore I bring ♉ 29 to the Eaſt ſide the Horizon, and find then at the Meridian 299. degrees 30. min. of the Equinoctial; then I turn the Place of the Sun to the Meridian, and find 56. deg. 30. min. of the Equinoctial come to the Meridian with it. Here the Equinoctial point ♈ paſſes through the Meridian while the Sun moves between the Horizon and the Meridian; Therefore as aforeſaid, I ſubſtract the firſt number of degrees, and minutes *viz.* 299. deg. 30. min. from 360. degrees, and there remaines 60. degr. 30. min. for the number of degrees and minutes contanied between the degree of the Equinoctial at the Meridian and the Equinoctial point *Aries*; and to this 60. deg. 30. min I ad the ſecond number of degrees and minutes *viz.* 56. degrees 30. min. the number of degrees and minutes between the point *Aries* and the deg. of the Equinoctial at the Meridian, and they make together 117. degrees, for the Suns Semi-diurnal Arch:

Arch: By doubling of which you have 234. degrees, for the Suns Diurnal Arch: And by ſubſtracting 234. (the Diurnal Arch) from 360. you have 126. degrees, for the Suns Nocturnal Arch.

Example, for a Star.

I take *Sirius*, a bright Star in the Great Dogs mouth. The Globe rectified, as before; I bring *Sirius* to the Eaſt ſide the Horizon, and find then 29. degrees 30 minutes of the Equinoctial at the Meridian, then I turn *Sirius* to the Meridian and find 97. degrees 38. minutes of the Equinoctial come to the Meridian with it: Therefore I ſubſtract the firſt numbers; *viz.* 29 deg. 30. minutes, from the ſecond, 97. 38. and the remains is 68. degrees 8. minutes, for the Semi-diurnal Arch of *Sirius*.

His Nocturnal Arch you may find as before.

PROB. XXXIX.

To find the Azimuth *and* Almicantar *of any Star.*

THis Probleme is like the 22, and 23. Problemes, which ſhew the finding the *Azimuth* and *Almicanter* of the Sun; only whereas there you were directed to bring the degree of the Sun to the Quadrant of Altitude, you muſt now bring the Star propoſed to the Quadrant of Altitude; and by the Directions in thoſe Problemes the reſolution will be found.

PROB. XL.

To find the Hour *of the* Night, *by obſerving two known Stars in one* Azimuth *or* Almicanter.

REctifie the Globe Quadrant and Hour Index. Then find the two known Stars on the Globe; and if the two Stars be in one *Azimuth*, turn about the Globe and Quadrant of Altitude till you can fit the two Stars to ly under the graduated edge of the Quadrant of Altitude: ſo ſhall the Index of the Hour-Circle point at the Hour of the Night. If

the two Stars be in one Almicantar, Turn the Globe forward or backward till the two Stars come to ſuch a poſition that by moving the Quadrant of Altitude, the ſame degree on it will ly on both the Stars; ſo ſhall the Index of the Hour-circle point at the Hour of the Night.

PROB. XLI.

The Hour given that any Star in Heaven comes to the Meridian, to know thereby the place of the Sun, and by conſequence the Day of the Moneth, though it were loſt.

BRing the Star propoſed to the Meridian, and turn the Index of the Hour-circle to the Hour given, Then turn about the Globe till the Index point at the hour of 12. for Noon; and the place of the Sun in the Ecliptick ſhall be cut by the Meridian.

Example.

March 7. at 11 a clock at Night the *Pointers* come to the Meridian of *London.* Therefore I place the *Pointers* (on the Celeſtial Globe) under the Meridian, and turn the Index of the Hour-circle to 11. paſt Noon, afterwards I turn back the Globe till the Index point to 12 at Noon; Then looking in the Ecliptick I find the Meridian cuts it in *Piſces* 26. 45 min. Therefore I ſay, when the *Pointers* come to the Meridian at 11 a clock at night, the place of the Sun is *Piſces* 26.45. Having thus the place of the Sun, I may find the day of the moneth by the fourth Probleme; and ſo either know the day that the *Pointers* come to the Meridian at 11 a clock at Night, or any other Hour given.

The day of the moneth might alſo be found by the Declination and the Quarter of the Ecliptick the Sun is in, given: For the Meridian will cut the degree of the Suns place in the Ecliptick in the Parallel of Declination: So that having reſpect to the quarter of the Ecliptick, you'le find the Suns place; and having the Suns place, you may (as aforeſaid) find the day of the moneth.

PROB.

PROB. XLII.

The Day of the Moneth given, to find in the Circle of Letters on the plain of the Horizon, the Day of the Week.

THe ſeven Daies of the Week were by the Idolatry of the ancient Romain Heatheniſh times dedicated to the honour of ſeven of their Gods, which we call *Planets.* The firſt is the moſt eminent, and therefore doubtleſs by them ſet in the firſt place, called *Dies Solis*, or the Suns Day: The ſecond *Dies Lunæ*, the Moons Day: The third *Dies Martis*, the Day of *Mars*: by us called *Tueſday*: The fourth *Dies Mercurij*, *Mercuries* Day: by us called *Wedneſday*: from *Woden*, an Idol the *Saxons* worſhipt, to whoſe honour they dedicated that Day, and is by all theſe *Germain* Nations ſtill called *Wodenſdagh*: The fifth *Dies Jovis*, *Jupiter* or *Joves* Day: which doubtleſſe the *Saxons* (from whom probably we receive it) called *Donderdagh*, becauſe *Jupiter* is the God of Thunder; and we either by corruption or for ſhortneſs, or both, call it *Thurſday*: The ſixth *Dies Veneris*, the Day of *Venus*: but the *Saxons* transferring her honour to another of their Goddeſſes named *Frea*, called it *Fridagh*: and we from them call it *Fryday*: The ſeventh is *Dies Saturni*, *Saturns* Day.

The ſame Day of the Moneth in other Years happens not on the ſame Day of the Week, therefore the Dominical Letter for one Year is not the ſame it is the next: Now becauſe you cannot come to the knowledge of the Day of the Week unleſs you firſt know the Sundaies Letter, therefore have I in Prob. 53. inſerted a Table of Mr *Palmers*, by which you may find the Dominical or Sundaies Letter for ever; and having the Dominical Letter you may in the Circle of Letters on the Horizon find it neer the day of that Moneth, and count that for *Sunday*, the next under it for *Monday*, the next under that for *Tueſday*, and ſo in order, till you come to the Day of the Moneth.

Example.

I would know what Day of the Week *June* 1. *Anno* 1658. Old Style, falls on; I find by the Table aforeſaid the Dominical

Letter is C, then I look in the Calender of Old Stile for *June* 1. and againſt it I find Letter E, which becauſe it is the ſecond Letter in order from C, therefore it is the ſecond day in order from *Sunday*, which is *Tueſday*.

PROB. XLIII.

The Azimuth *of any Star given, to find its* Hour *in any given* Latitude.

THe Hour of a Star is the number of Hours that a Star is diſtant from the Meridian. To find which, Rectifie the Globe and Quadrant of Altitude, and bring the Star propoſed to the Meridian, and the Index of the Hour Circle to 12. Then place the lower end of the Quadrant of Altitude to the given Azimuth in the Horizon, and turn the Globe till the Star come to the graduated edge of the Quadrant of Altitude; ſo ſhall the Index of the Hour-Circle point at the hour of the Star. Only this caution you muſt take; If the Star were turned from the Meridian towards the Eaſtern ſide of the Horizon, you muſt ſubſtract the number of hours the Index points at from 12. and the remainder ſhall be the Hour of the Star. But if the Star were turned from the Meridian towards the Weſt ſide the Horizon, the Hour Index points at, is (without more adoe) the Hour of the Star.

PROB. XLIV.

How you may learn to know all the Stars in Heaven, by the Celeſtial Globe.

REctifie the Globe, Quadrant, Hour-Index, and Horizon, as by Prob. 2. Then turn about the Globe, till the Index of the Hour-Circle point at the Hour of the Night on the Hour-circle. Then if every Star on the Globe had a hole in the midſt, and your Ey were placed in the center of the Globe; you might by keeping your Ey in the center and looking through any Star on the Globe ſee its Match in Heaven: that is, the ſame Star in Heaven which that Star on the Globe repreſents: for from the center of the Globe there proceeds a ſtraight line

line through the Star on the Globe, even to the ſame Star in Heaven. Therefore thoſe Stars that are in the Zenith in Heaven, will then be on the Zenith on the Globe; thoſe that are in the Eaſt in Heaven, will be in the Eaſt on the Globe; thoſe in the Weſt in Heaven, in the Weſt on the Globe; and thoſe Stars that are in any Altitude in Heaven, will at the ſame time have the ſame Altitude on the Globe; So that if you ſee any Star in Heaven whoſe Name you deſire to know, you need but obſerve its Azimuth and Altitude, and in the ſame Azimuth and Altitude on the Globe, you may find the ſame Star: and if it be an eminent Star, you will find its name adjoyned to it.

Example.

December 10. at half an hour paſt 9 a clock at Night, here at *London*, I ſee two bright Stars at a pretty diſtance one from another in the South; I deſire to know the Names of them: Therefore having the Globe rectified to the Latitude of *London*, and the Quadrant of Altitude ſcrewed to the Zenith, the Hour-Index alſo rectified, and the Horizon poſited Horizontally, as by Prob. 2. I obſerve the Altitude of thoſe Stars in Heaven, (either with a Quadrant, Aſtrolabe, Croſs-ſtaff, or the Globe it ſelf, as hath been ſhewed Prob. 13. 16.) to be, the one 78 degrees, the other 42 degrees above the Horizon. Therefore having their Altitudes, I count the ſame number of degrees as for the firſt 78 upon the Quadrant of Altitude upwards, and turn it into the South, under the Meridian, and ſee what Star is under 78 degrees, for that is the ſame Star on the Globe which I ſaw in Heaven. Now at the firſt examination of the Globe you may ſee that that Star is placed in the Ey of that Aſteriſme which is called *Caput Meduſa*, and indeed, that being the only Star of note in that Conſtellation, bears the Name of the whole Conſtellation. The other Stars about it you may eaſily know by their Scituation: As ſeeing two little Stars to the Weſtwards of that Star in Heaven, you may ſee on the Globe that the hithermoſt is in the other Ey of *Caput Meduſa*, and the furthermoſt in the *Hair* or *Snakes* of the ſame Aſteriſme. Looking a little to the Southwards of thoſe Stars in Heaven, you may ſee two other ſmal Stars a little below thoſe in the *Eyes*; Therefore to know thoſe alſo, you may look on the Globe, and ſee that there is one on the

Nese, and another Star in the *cheek* of *Caput Medusæ*.

In like manner for the second Star in the Meridian, which is 42 degrees above the Horizon: If you move the Quadrant of Altitude (as before) to the South or Meridian, and count 42 degrees upon the Quadrant of Altitude, you will find a Star of the second Magnitude in the *Mouth* of the *Whale*: Therefore you may say that Star in Heaven is in the *Mouth* of the *Whale*: and because close to it on the Globe is written *Menkar*, Therefore you may know the name of that Star in Heaven is *Menkar*.

In the South East and by South 56 degrees above the Horizon, I see a very bright Star in Heaven; therefore I bring the Quadrant of Altitude to the South East and by South point in the Horizon, and find under 56 degrees of the Quadrant of Altitude a great Star, to which is set the name *Occulus Tauri*; Therefore I say the name of that bright Star in Heaven is *Occulus Tauri*.

In the South East in Heaven you may see three bright Stars ly directly in a straight line from one another, the middlemost whereof is 25 degrees or thereabouts above the Horizon, therefore bring the Quadrant of Altitude to the SouthEast point of the Horizon, and about 25 degrees above the Horizon you will see the same great Stars on the Globe in the *Girdle* of *Orion*: Therefore those Stars are called *Orions Girdle*.

At the same time South East and by East you have about 10 degrees above the Horizon the brightest Star in Heaven, called *Sirius*, in the *Mouth* of the *Great Dog*; *Canicula* a bright Star in the *Little Dog* East and by South, about 25 degrees above the Horizon: *Cor Leonis* just Rising East North East: you have also at the same time on the East side the Horizon, the *Twins*, *Auriga*, the *Great Bear*; and divers other Stars, eminent both for their splendor and magnitude.

In the West side the Horizon you have South West and by West about 4 degrees above the Horizon a bright Star in the *Right Leg* of *Aquarius*: and all along to the Southwards in *Cetus* the *Whale*, you have other eminent bright Stars: More upwards towards the Zenith you have a bright Star in the *Line* of the two *Fishes*: Higher yet, you have the first Star in ♈, an eminent Star, because the first in all Catalogues that we have cognizance of; and therefore probably in the Equinoctial Colure when the Stars were first reduced into Constellations: yet more

neer

neer the Zenith you have a bright Star in the *Left Leg* of *Andromeda*: From thence towards the North, you find other very eminent bright Stars in *Cassiopea*, *Cepheus*, *Ursa minor*, in the Tail whereof is the *Pole Star*: and *Draco*: *Hercules*: where you turn back to *Lyra*, *Cygnus*, *Pegasus*, the *Dolphin*, &c. all which, or any other, you may easily know by their Altitude above the Horizon, and the point of the Compass they bear upon.

Thus knowing some of the most eminent fixed Stars, you may by the Figure of the rest come to the knowledge of them also. For example, Looking towards the North North East in Heaven, you may see seven bright Stars constituted as in this Fig. Therefore looking towards the same Quarter on the Globe, you may (without taking their Altitude) see the same Stars lying in the same Figure in the hinder parts of the *Great Bear*; from whence you may conclude that those Stars in Heaven are scituate in the hinder parts of the Great Bear. These 7 Stars are by us called *Charles his Wain*.

Yet nevertheless you may see some Stars of note in Heaven, which you shall not find on the Globe, and those in or neer about the Ecliptick: They are called *Planets*, and cannot be placed on the Globe, unless it be for a particular Time, with Black lead, or some such thing that may be rubbed out again: Because they having a continual motion, always alter their places. Of those there are five in number, besides the *Sun* and *Moon*, which are also Planets, though they shew not like Stars. These five are called *Saturn*, *Jupiter*, *Mars*, *Venus*, *Mercury*; yet *Mercury* is very rarely seen: because he never rising above an Hour before the Sun, or setting above an Hour after, for the most part hath his light so overspread with the dazelling beams of the glittering Sun, that sometimes when he is seen he seems rather to be a mote in the Suns beams, than a body endowed with so much brightness as Stars and Planets seem to be.

Now there are divers waies (by some of which) you may at all times know those Planets from the fixed Stars: as first, Their not twinkling, for therein they differ from fixed Stars; because they most commonly do twinkle, but Planets never; unless it be *Mars*; and yet he twinkles but very seldom neither.

Secondly, They appear of a considerable Magnitude, as 4 some-

ſometimes appears greater by far than a Star of the firſt Magnitude; and ♀ many times bigger than he. They are both gliſtering Stars, of a bright Silver collour but ♀ moſt radient, eſpecially when ſhe is in her *Perigeon*. ♂ appears like a Star of the ſecond Magnitude; and is of a Copperiſh collour. ♄ ſhews like a Star of the third Magnitude, and is of a Leaden Collour; and he (of all others,) is moſt difficult to be known from a fixed Star, partly becauſe of his minority, and partly becauſe of the ſlowneſs of his motion. ☿ is very ſeldom ſeen (as aforeſaid) unleſs it be in a Morning when he Riſes before the Sun, or in an Evening when he Sets after the Sun: He is of a pale whitiſh collour, like Quick-ſilver, and appeares like a Star of the Third Magnitude He may be known by the company he keeps, for he is never above 29 degrees diſtant from the Sun.

Thirdly the Planets may be known from the fixed Stars by their Azimuths and Altitudes obſerved (as hath been taught before) for if when you have taken the Azimuth and Altitude of the Star in Heaven you doubt to be a Planet, and you find not on the Globe in the ſame Azimuth and Altitude a Star appearing to be of the ſame Magnitude that that in Heaven appears to be, you may conclude that that in Heaven is a Planet. Yet notwithſtanding it may happen that a Planet may be in the ſame degree of Longitude and Latitude in the Zodiack that ſome eminent fixed Star is in, as in the degree and minute of Longitude and Latitude that *Cor Leonis*, or the *Buls Ey*, or *Scorpions heart* is in, and ſo may eclipſe that Star, by being placed between us and it; But that happens very ſeldom and rarely; but if you doubt it, you may apply your ſelf to ſome other of the precedent and ſubſequent Rules here ſet down for knowing Planets from fixed Stars.

The fourth way is by ſhifting their places; for the Planets having a continual motion, do continually alter their places: as ♂ moves about half a degree in a day: ♀ about a whole degree; but ♃ and ♄ move very ſlowly; ♃ not moving above 5 minutes, and ♄ ſeldom above 2 minutes Yet by their motions alone the Planets may be known to be Planets, if you will preciſely obſerve their diſtance from any known fixed Star in or neer the Ecliptick: as, On this night and the next night after, obſerve whether they retain the ſame diſtance they had the night before; which if they do, then are they fixed Stars; but if they do not, then are they Planets: yet this caution is to be given you in this Rule alſo,

that

That the Planets ſometime, are ſaid to be *Stationary*, as not altering a minute in Place forwards, or backwards in 6. or 7. daies together. Threfore, if you find cauſe to doubt whether your Star be a Planet, or a fixed Star, you may for the help of your underſtanding confer with ſome of the former Rules, unleſs you are willing to wait 8, or 9. daies longer, and ſo by obſervation of its motion reſolve your ſelf. Or

Fifthly, you may apply your ſelf to an Ephemeris for that Year, and ſee if on that day you find any Planet in the degree and minute of the Zodiack you ſee that Star you queſtion in Heaven; and if there be no Planet in that degree of the Zodiack, you may conclude it is no Planet, but a fixed Star.

PROB. XLV.

How to hang the Terreſtrial Globe in a ſuch poſition that by the Suns ſhining upon it you may with great delight at once behold the demonſtration of many Principles in Aſtronomy, *and* Geography.

TAke the Terreſtrial Ball out of the Horizon, and faſten a thred on the Brazen Meridian to the degree of the Latitude of your Place; by this thred hang the Globe in a place where the Suns Beames may have a free acceſs to it; Then direct the Poles of the Globe to their proper Poles in Heaven, the North Pole to the North, and the South Pole to the South; and with a thred faſtned to either Pole, brace the Globe ſo, that it do not turn from its poſition: Then bring your Habitation to the Meridian; ſo ſhall your Terreſtrial Globe be Rectified to correſpond in all reſpects with the Earth it ſelf; even as in Prob. 44. the Celeſtial Globe doth; the Poles of the Globe to the Poles of the World; the Meridian of the Globe to the Meridian of the World; and the ſeveral Regions on the Globe made correſpondent to the ſame Regions on the Earth: So that with great delight you may behold,

1. How the conterfeit Earth (like the true one) will have one Hemiſphear Sun-ſhine light, and the other ſhadowed, and as it were dark. By the lightned Hemiſphear you may ſee that it is Day in all Places that are ſcituate under it; for on them the Sun doth ſhine; and that it is Night at the ſame time in thoſe Places

that are ſcituate in the ſhadowed Hemiſphear; for on them the Sun doth not ſhine; and therefore they remain in darkneſs.

2. If in the middle of the enlightned Hemiſpear you ſet a Spherick Gnomon Perpendicularly, it will project no ſhadow, but ſhews that the Sun is juſt in the Zenith of that Place; that is directly over the heads of the inhabitants of that Place: and the point that the Spherick Gnomon ſtands on, being removed to the Meridian ſhews the Declination of the Sun on the Meridian for that Day.

3. If you draw a Meridian line from one Pole to the other; in all Places under that line, it is Noon: in thoſe Places ſcituate to the Weſt it is Morning, for with them the Sun is Eaſt: and in thoſe Places ſcituate to the Eaſt it is Evening; for with them the Sun is Weſt.

4. Note the degree of the Equator where the enlightned Hemiſphear is parted from the ſhadowed; for the number of degrees of the Equator intercepted between that degree and the Meridian of any Place converted into hours (by accounting for every 15. degrees 1 hour) ſhews, if the Sun be Eaſtwards of that Place how long it will be ere the Sun Riſes, Sets, or comes to the Meridian of that Place, or if the Sun be Weſtward of that Place how long it is ſince the Sun Roſe or Set, or was at the Meridian of that Place.

5. The Inhabitants of all Places between the enlightned and ſhadowed Hemiſphere, behold the Sun in the Horizon: Thoſe Weſtwards of the Meridian Semi-circle drawn through the middle of the enlightned Hemiſphere behold the Sun riſing: Thoſe in the Eaſt, ſee it Setting.

6. So many degrees as the Sun reaches beyond either the North or South Pole, ſo many degrees is the Declination of the Sun, either Northwards or Southwards: and in all thoſe Places comprehended in a Circle deſcribed at the termination of the Sun-ſhine, about that Pole, it is alwaies Day, till the Sun decreaſe in Declination: for the Sun goes not below their Horizon, as you may ſee by turning the Globe about upon its Axis, and in the oppoſite Pole, at the ſame diſtance, the Sun-ſhine not reaching thither, it will be alwais Night, till the Sun decreaſe in Declination: becauſe the Sun Riſes not above their Horizon.

7. If you let the Globe hang ſteddy, you may ſee on the Eaſt ſide of the Globe, in what places it grows Night; and on the Weſt

Weſt ſide the Globe how by little and little the Sun encroaches upon it; and therefore makes it Day.

8. If you make of paper or parchment a narrow Girdle, to begirt the Globe juſt in the Equinoctial, and divide it into 24 equal parts, to repreſent the 24 hours of Day and Night, and mark it in order with I, II, III, &c. to XII. and then begin again with I, II, III, &c. to the other XII. you may by placing one of the XII. upon the Equinoctial under the Meridian of your place, have a continual Sun-dyal of it, and the hour of the Day given on it at once in two places; one by the parting the enlightned Hemiſphear from the ſhadowed on the Eaſtern ſide, the other by parting the enlightned Hemiſphear from the ſhadowed on the Weſtern ſide the Globe. Much more might be ſaid on this Probleme: But the Ingenuous Artiſt may of himſelf find out diverſities of Speculations: therefore I forbear.

PROB. XLVI.

To know by the Terreſtrial Globe in the Zenith of what Place of the Earth the Sun is.

THis may be performed by the former Probleme in the Day time, if the Sun ſhines: but not elſe. But to find it at all times, do thus. Bring the place for your Habitation to the Meridian, and the Index of the Hour-circle to 12; Then turn the Globe Eaſtwards, if After noon, or Weſtwards, if Before Noon, till the Index of the Hour-circle paſs by ſo many Hours from 12 as your Time given is, either before or after noon: ſo ſhall the Sun be in the Zenith of that place where the Meridian interſects the Parallel of the Suns Declination for that Day.

Example.

May 10. at three quarters of an hour paſt 4 a clock after noon, I would know in what place of the Earth the Sun in the Zenith. My Habitation is *London*. Therefore I bring *London* to the Meridian, and the Index of the Hour-circle to 12. and becauſe it is After Noon, I turn the Globe Eaſtwards, till the Index paſſes through 4 hours and 3 quarters, or (which is all one) all 70 degrees 15 minutes of the Equator paſs through the Meri-

ridian. Then I find by Prob. 5. the Suns Declination is 20 degrees 5 minutes, which I find upon the Meridian, and in that Place just under that degree and minute on the Globe, the Sun is in the Zenith: which in this Example is in the North East Cape of *Hispaniola.*

Having thus found in what place of the Earth the Sun is in the Zenith. Bring that place to the Meridian, and elevate its respective Pole according to its respective Elevation; so shall all Places cut by the Horizon have the Sun in their Horizon: Those to the Eastwards shall have the Sun Setting; those to the Westwards shall have it Rising in their Horizon: those at the intersection of the Meridian and Horizon under the elevated Pole, have the Sun in their Horizon at lowest, but Rising; those at the intersection of the Meridian and Horizon under the Depressed Pole, have the Sun in their Horizon at highest, but Setting. Thus in those Countries that are above the Horizon it is Day light, and in those but 18 degrees below the Horizon it is Twilight: But in those Countries further below the Horizon it is at that time dark Night: And those Countries within the Parallel of the same number of degrees from the Elevated Pole that the Suns Declination is from the Equinoctial, have the Sun alwaies above the Horizon, till the Sun have less respective Declination than the Elevated Pole; and those within the same Parallel of the Depressed Pole have the Sun alwaies below their Horizon, till the Sun inclines more towards the Depressed Pole; As you may see by turning about the Globe; for in this position, that portion of the Globe intercepted between the Elevated Pole, and the Parallel Circle of 20. degrees 5 minutes from the Pole, doth not descend below the Horizon: neither doth that portion of the Globe intercepted between the Depressed Pole and the Parallel Circle within 20 deg. 5 min. of that Pole ascend above the Horizon.

PROB. XLVII.

To find in what different Places of the Earth the Sun hath the same Altitude *at the same time.*

FInd by the former Probleme in what Place of the Earth the Sun is in the Zenith, and bring that Place on the Globe

Globe to the Zenith, and on the Meridian [there] ſcrew the Quadrant of Altitude, and turn it about the Horizon, deſcribing degrees of Almicantars thereby, as by Prob. 23. and all thoſe Countries in any Almicantar on the Globe, ſhall have the Sun elevated the ſame number of degrees above their Horizon. Thus thoſe Countries in the tenth Almicantar ſhall have the Sun Elevated 10. degrees above their Horizon; thoſe in the 20th Almicantar ſhall have the Sun Elevated 20 degrees above their Horizon; thoſe in the 30th, 30 degrees &c. So that you may ſee, when the Sun is in the Zenith of any Place, All the Countries or Cities in one and the ſame Almicantar have the Sun in one heighth at the ſame time above their Horizon. But to find in what different Places the Sun hath the ſame heighth at the ſame time, as well Before or After Noon, as at Full Noon; and that in Countries that have greater Latitude then the Suns greateſt Declination, (and therefore cannot have the Sun in their Zenith,) requires another Operation.

Therefore, Elevate its reſpective Pole according to your reſpective Latitude; and let the Degree of the Brazen Meridian which is in the Zenith repreſent your Habitation, and the degree of the Ecliptick the Sun is in repreſent the Sun: Then bring the Sun to the Meridian, and the Index of the Hour-Circle to 12, and turn the Globe Eaſtwards, if Before Noon, or Weſtwards, if After Noon, till the Index point to the hour of the Day: Then place the lower end of the Quadrant of Altitude to the Eaſt point of the Horizon, and move the upper end (by ſliding the Nut over the Meridian) till the edge of the Quadrant touch the place of the Sun: Then ſee at what degree of the Meridian the upper end of the Quadrant of Altitude touches the Meridian and ſubſtract that number of degrees from the Latitude of your Place, and count the number of remaining degrees on the Meridian, on the contrary ſide the degree of the Meridian where the upper end of the Quadrant of Altitude touches the Meridian, and where that number of degrees ends, on the Meridian, in that Latitude and your Habitations Longitude, hath the Sun the ſame height at the ſame time.

Example.

May 10. at 53. minutes paſt 8. a clock in the Morning I

would know in what Place the Sun ſhall have the ſame Altitude it ſhall have at *London*. *Londons* Latitude found by Prob. 1. is 51 ½ degrees Northward: And becauſe the Elevation of the Pole is equal to the Latitude of the Place (as was ſhewed Prob. 15.) Therefore I elevate the North Pole 51 ½ degrees, ſo ſhall 51 ½ degrees on the Meridian be in the Zenith: This 51 ½ degrees on the Meridian repreſents *London*. The Suns place found by Prob. 3. is ♉ 29. Therefore I bring ♉ 29 to the Meridian, and the Hour-Index to 12. on the Hour circle: Then I turn the Globe Eaſtwards (becauſe it is before Noon) till the Index point at 8 hours 53 minutes on the Hour circle, and place the lower end of the Quadrant of Altitude to the Eaſt point in the Horizon, and ſlide the upper end either North or Southwards on the Meridian till the graduated edge cut the degree of the Ecliptick the Sun is in: Then I examine on the Meridian what degree the upper end of the Quadrant of Altitude touches; which in this example I find is 28 degrees; Therefore I ſubſtract 28 from 51 ½ *Londons* Latitude, and there remains 23 ½. Then counting on the Meridian 23 ½ degrees backwards, from the point where the Quadrant of Altitude touched the Meridian, I come to 4 degrees on the Meridian, Northwards. Therefore I ſay, In the North Latitude of 4 degrees, and in the Longitude of *London* (which is about *C. Apolonia* on the coaſt of *Guinea*) the Sun *May* 10. at 53 min. paſt 8 a clock in the Morning hath the ſame Altitude above the Horizon it hath here at *London*.

The Quadrant of Altitude thus applyed to the Eaſt point of the Horizon makes right angles with all points on the Meridian, even as all the Meridians proceeding from the Pole do with the Equator: therefore the Quadrant being applyed both to the Eaſt point and the Suns place, projects a line to interſect the Meridian in the middle point between the Latitude of your Habitation and the Latitude of that Place in which the Sun ſhall have the ſame Altitude it hath at your Habitation at the ſame time. Thus it falls out that thoſe that inhabite 5 deg. to the Northwards of this interſection, have the Sun the ſame height that they have that inhabite 5 deg. to the Southwards of it: and thoſe 10, 20, 30. deg. more or leſs to the Northwards, have the Sun in the ſame heigth that they have that are 10, 20, 30. deg. more or leſs to the Southwards: So that this Prob. may be done yet eaſlyer with your Compaſſes, thus; The Globe and Hour-Index rectified: Turn about the Globe till the

the Hour-Index point to the Hour of the Day: Then pitch one foot of your Compasses in the Suns place, and extend the other to the degree of Latitude on the Meridian, which in this example is 51 ½ deg. North; then keeping the first foot of your Compasses on the degree of the Sun, turn about the other foot to the Meridian, and it will fall upon 28, as before.

By this Probleme you may take notice how grosly they err that think they can find the heigth of the Pole at any hour of the Day, by the Suns heigth: because they do not consider that it is impossible to find the Hour of the Day, unless they first know the heigth of the Pole.

PROB. XLVIII.

To find the length of the Longest and Shortest Artificial Day or Night.

THe Artificial Day is that space of Time which the Sun is above the Horizon of any Place: and the Artificial Night is that space of Time which the Sun is under the Horizon of any Place. They are measured in the Hour-Circle, by Hours and Minutes.

There is a constant and unequal disproportion in the length of these Daies and Nights; which is caused both by the alteration of the Suns Declination, and the difference of the Poles Elevation.

Those that inhabite on the North side the Equator have their longest day when the Sun enters *Cancer*; and those that inhabite on the South side the Equator, have their longest day when the Sun enters *Capricorn*. But to know how long the longest day is in any North or South Elevation, Raise the North or South Pole according to the Elevation of the Place, and bring *Cancer* for North Elevation, or *Capricorn* for South Elevation to the Meridian, and the Index of the Hour-circle to 12. Then turn the Globe about till *Cancer* for North or *Capricorn* for South Elevation come to the West side the Horizon, and the number of Hours and minutes pointed at on the Hour-circle doubled, is the number of Hours and minutes of the Longest Day.

The length of the Night to that Day is found by substracting the length of the day from 24. for the remainder is the length of the Night.

The

The ſhorteſt Day in that Latitude is the length of the ſhorteſt Night, found as before. And the longeſt Night is of the ſame length with the longeſt Day.

Example.

I would know the length of the longeſt Day at *London*. Therefore I Elevate the North Pole 51½. degrees and bring ♋ to the Meridian, and the Index of the Hour Circle to 12. Then I turn ♋ to the Weſtern ſide the Horizon, and find the Index point at 8. hours 18. minutes, which being doubled makes 16. hours 36. minutes, for the length of the longeſt Day here at *London*.

PROB. XLIX.

To find how much the Pole is Raiſed or depreſſed, where the longeſt Day is an Hour longer or ſhorter then it is in your Habitation.

REctifie the Globe to the Latitude of your Place; and make a prick at that point of the Tropick which is at the Meridian; I mean at the Trop. of *Cancer*, if your Habitation be on the North ſide the Equator; or ♑ if your Habitation be on the South ſide the Equator: And if you would know where the longeſt Day is juſt an hour longer then it is at your Habitation turn the Globe to the Weſtward till 7½. degrees of the Equator paſs through the Meridian, and make there another prick on the Tropick: then turn about the Globe till the firſt prick come to the Horizon; and move the Meridian through the notches of the Horizon till the ſecond prick on the Tropick come to the Horizon; ſo ſhall the Arch of the Meridian contained betwcen the Elevation of your Place, and the degree of the Meridian at the Horizon, be the number of degrees that the Pole is Elevated higher then it is in your Latitude.

Example.

I would know in what Latitude the longeſt Day is an hour longer then it is at *London*. Therefore I Rectifie the Globe to 51½. deg. and where the Meridian cuts the Tropick of ♋ I make a prick

a prick; then I note what degree of the Equator is at the Meridian, and from that degree on the Equator count $7\frac{1}{2}$ degrees to the Eaſtwards, and bring thoſe $7\frac{1}{2}$ degrees to the Meridian alſo; and again where the Meridian cuts the Tropick of ♋ I make another prick, ſo ſhall $7\frac{1}{2}$ degrees of the Tropick be contained between thoſe two pricks: Then I turn the Globe about till the firſt prick comes to the Horizon, and (with a Quill thruſt between the Meridian and the Ball) I faſten the Globe in this poſition: Afterwards I move the Meridian through the notches of the Horizon, till the ſecond prick riſes up to the Horizon, and then I find $56\frac{1}{2}$ degrees of the Meridian cut by the ſuperficies of the Horizon: Therefore I ſay, In the Latitude of $56\frac{1}{2}$ degrees the longeſt Day is an hour longer than it is here at *London.*

But if you would know in what Latitude the Dayes are an Hour ſhorter, you muſt make your ſecond prick $7\frac{1}{2}$ degrees to the Weſtwards of the firſt, and after you have brought the firſt prick to the Horizon, you muſt depreſs the Pole till the ſecond prick deſcends to the Horizon: ſo ſhall the degree of the Meridian at the Horizon ſhew in what Elevation of the Pole the Daies ſhall be an Hour ſhorter.

By this Probleme may be found the alteration of Climates: for (as was ſaid in the Definition of Climates, *Book* 1. *fol.* 28.) Climates alter according to the half-hourly increaſing of the longeſt Day: therefore the Latitude of $56\frac{1}{2}$ degrees having its Daies increaſed an whole Hour) is diſtant from the Latitude of *London* by the ſpace of two Climates.

PROB. L.

The Suns place given, to find what alteration of Declination it muſt have to make the Day an Hour longer or ſhorter: And in what number of Daies it will be.

RE ctifie the Globe to the Latitude of the Place, and bring the Suns place to the Eaſt ſide the Horizon, and note againſt what degree of the Horizon it is: then bring one of the Colures to interſect the Horizon in that degree of the Horizon, and at the point of interſection make a prick in the Colure; and obſerve what degree of the Equator is then at the Meridian: Then turn the Globe Weſtward, if the Daies ſhorten, but Eaſtwards if

they lengthen till 7½ degrees of the Equator paſs through the Meridian, and where the Horizon interſects the ſame Colure, make another prick in the Colure: afterwards bring the Colure to the Meridian, and count the number of degrees between the two pricks, for ſo many degrees muſt the Suns Declination alter to lengthen or ſhorten the Day an Hour.

Example.

The Suns Place is ♉ 10. I would know how much he muſt alter his Declination before the Day is an Hour longer here at *London*. Therefore I rectifie the Globe to the Latitude of *London*, and bring ♉ 10 to the Eaſt ſide the Horizon, and find it againſt 24½ degrees from the Eaſt point: therefore I bring one of the Colures to this 24½ degrees, and cloſe by the edge of the Horizon I make a prick with black lead, in the Colure: then keeping the Globe in this poſition, I look what degree of the Equator is then at the Meridian, and find 250. 15, and becauſe the Daies lengthen, I turn the Globe Eaſtwards till 7½ degrees from the aforeſaid 250. 15 paſs through the Meridian: then keeping the Globe in this poſition, I make another prick in the Colure, and bringing this Colure to the Meridian, I find a little more then 5 degrees of the Meridian contained between the two pricks: therefore I ſay, when the Sun is in ♉ 10. degrees he muſt alter his Declination a little more than 5 degrees to make the Day an Hour longer.

Now to know in what number of daies he ſhall alter this Declination, you muſt find the Declination of the two pricks on the Colure, as you found the Suns Declination by Prob. 5. and the Arch of the Ecliptick that paſſes through the Meridian while the Globe is turned from the firſt prick's Declination to the ſecond pricks Declination, is the number of Ecliptical degrees that the Sun is to paſs while he alters this Declination; and the degree of the Ecliptick then at the Meridian is (with reſpect had to the Quarter of the Year) the place the Sun ſhall have when its Declination ſhall be altered ſo much as to make the Day an Hour longer.

Thus having the Suns firſt place given, and its ſecond place found; you may by finding thoſe two places on the plain of the Horizon, alſo find the number of daies comprehended between them, as you are taught by the fourth Probleme.

This

This Probleme thus wrought for different times of the Year, will ſhew the falacy of that Vulgar Rule which makes the Day to be legthned or ſhortned an hour in every Fifteen Daies: when as the lengthning or ſhortning of Daies keeps no ſuch equality of proportion: for when the Sun is neer the Equinoctial points the Daies lengthen or ſhorten very faſt: but when he is neer the Tropical points, very ſlowly.

PROB. LI.

Of the Difference of Civil *and* Natural Daies, *commonly called the* Equation *of* Civil Daies. *And how it may be found by the* Globe.

THe Civil Day is that ſpace of time contaning juſt 24. Hours, reckoned from 12 a clock on one Day to 12. a clock the next Day; in which ſpace of time the Equinoctial makes upon the Poles of the World a Diurnal Revolution. The Natural Day is that ſpace of Time wherein the Sun moveth from the Meridian of any Place to the ſame Meridian again. Theſe Daies are at one time of the Year longer than at another; and at all times longer than the Civil Daies. There is but ſmal diſcrepancy between them, yet ſome there is, made by a twofold Cauſe. For firſt, The Suns Apparent motion is different from his true motion; He being much ſlower in his *Apogeum* than he is in his *Perigeum*: For when the Sun is in his *Apogeum* he ſcarce moves 58 minutes from Weſt to Eaſt in a Civil Day, but when he is in his *Piregeum* he moves above 61. minutes in a Civil Day: and therefore increaſes his Right Aſcenſion more in equal time.

The ſecond Cauſe is the difference of Right Aſcenſions anſwerable to equal parts of the Ecliptick: for about ♋ and ♑ the differences of Right Aſcenſions are far greater than about ♈ and ♎: for about ♈ and ♎ the Right Aſcenſion of 10. degrees is but 9. degrees 11. minutes; but about ♋ and ♑ the Right Aſcenſion of 10 degrees will be found to be 10. degrees 53. minutes; as by the Globe will appear.

But becauſe of the ſmalneſs of the Globes graduation, you cannot actually diſtinguiſh to parts neer enough for the ſolution of this Probleme, if you would enquire the difference in length of two ſingle Daies; it will be requiſite to take ſome number of

Daies together; Suppoſe 20. Therefore I find by Prob. 3. the Places of the Sun for the beginning and ending of thoſe Daies you would compare; and find the Right Aſcenſions anſwerable to each place in the Ecliptick; and alſo the differences of Right Aſcenſions anſwerable to the Suns motion in each number of Daies: Then compare the differences of Right Aſcenſions together; and by ſubſtracting the leſſer from the greater, you will have the number of degrees and minutes of the Equator that have paſſed through the Meridian more in one number of Daies than in the other number of Daies: which degrees of the Equator converted into Time, is the number of minutes that the one number of Daies is longer than the other number of Daies.

Example.

I would know what difference of Time there is in the length of the firſt 20. Daies of *December*, and the firſt 20. Daies of *March*. I find by Prob. 3. the Suns place *December* 1, is ♐ 19. 45. at the end of 20 Daies, *viz.* on the 21 Day his place is ♑ 10. 11. The Suns place *March* 1. is ♓ 21. 16. at the 20. Daies end, *viz. March* 21. his place is ♈ 11 3.

I find by Prob. 26. the Right Aſcenſion anſwerable to

♐ 19. 45			258. 10.
♑ 10. 11		is	280. 25.
♓ 21. 16			352. 00.
♈ 11. 3			9. 40.

and the difference of Right Aſcenſions contained between the firſt Day in each Moneth, and the 21 of the ſame Moneth, by ſubſtracting the leſſer from the greater is for

258. 10.	And for	352 00.
280. 25.		9. 40.
22. 15.		17. 40.

But note, becauſe the Vernal Colure (where the degrees of Right Aſcenſion begin and end their account) is intercepted in the Arch of the Suns motion from the firſt to the 21. of *March*, therefore inſtead of ſubſtracting the leſſer number of degrees of Right Aſcenſion from the greater *viz.* 9. 40 from 352. I do for finding the difference of the Right Aſcenſional arch of the Suns motion in thoſe 20 Daies, ſubſtract the foreſaid 352. deg. from 360, and the remains is 8. which is the difference of Right Aſcenſion from ♓ 21. 16. to the Equinoctial Colure: to which 8. adding

adding 9 degrees 40 minutes, the Right Aſcenſion from the Equinoctial Colure, to ♈ 11. 3. it makes 17 degrees 40 minutes for the difference of Right Aſcenſions between ♓ 21. 16. and ♈ 11. 3. Then I find the difference of this Difference of Right Aſcenſion, by ſubſtracting the leſs from the greater, viz. 17. 40. from 22. 15. and the remains is 4 degrees 35 minutes, for the number of degrees and minutes of the Equator that paſs through the Meridian in the firſt 20 daies in the moneth of *December* more than in the firſt 20 daies of the moneth of *March*: which 4 degrees 35 minutes converted into Time, gives 19 minutes, that is, a quarter of an Hour and 4 minutes that the firſt 20 Daies of *December* aforeſaid, are longer than the firſt 20 Daies of *March*.

PROB. LII.

How to find the Hour of the Night, when the Moon ſhines on a Sun Dyal, by help of the Globe.

REctifie the Globe, and find by Prob. 54 or an *Ephemeris*, the Moons place at Noon: Bring it to the Meridian, and the Index of the Hour Circle to 12. and turn about the Globe till the Index of the Hour Circle points to the ſame Hour the ſhade of the Moon falls on on the Sun Dyal. Then by Prob. 3. find the Suns place at Noon, and ſee how many degrees of Right Aſcenſion are contained between the Suns place and the degree of the Equator at the Meridian, when the Index of the Hour circle is brought to the Hour the Moon ſhines on in the Sun Dyal; for thoſe number of degrees converted into Time, ſhall be the Time from Noon, or the Hour of the Night Only note, Reſpect muſt be had to the motion of the Moon from Weſt to Eaſt, for ſo ſwift is her mean motion, that it is accounted to be above 12 degrees in 24 Hours: that is 6 degrees in 12 Hours. 3 degrees in 6 Hours, &c. and this alſo converted into Time, as aforeſaid, you muſt ad proportionably to the Time found from Noon; and the ſum ſhall give you the true Hour of the Night.

Example.

Here at *London* I deſired to know the Hour of the Night *January* 6. this preſent Year 1658. The Moons place found by

an Ephemeris, or for want of an Ephemeris, by Prob. 54. is in ♊ 21 degrees 22 minutes; Therefore I rectified the Globe to *Londons* Latitude and brought ♊ 21. 22. minutes to the Meridian, and the Index of the Hour circle to 12. then by Prob. 3. I found the Suns place in ♍ 26 degrees 46 minutes, and by Prob. 26. I found his Right Aſcenſion to be 300 degrees; Then I turn'd about the Globe till the Index of the Hour circle pointed at 10 Hours, and at the degree of the Equator at the Meridian I made a prick; then I accounted the number of degrees of the Equator contained between the foreſaid 300 deg. and this prick, and found them 111 ¼ degrees, which converted into Time, by allowing 15 degrees for an Hour, gives 7 hours, 25 minutes, Time from Noon: which if the Moons motion were not to be conſidered, ſhould be the immediate Hour of the Night: But by the Rule aforeſaid, the Moons motion from Weſt to Eaſt, in 7. hours 25. minutes is 3. degrees 42. minutes, and this 3. degrees 42. minutes being converted into Time, is 14. minutes more, which being added to 7. hours 25. minutes: makes 7. hours 39. minutes, for the true Hour of the Night.

PROB. LIII.

To find the Dominical Letter, *the* Prime, Epact, Eaſter Day, *and the reſt of the* Moveable Feaſts, *for ever.*

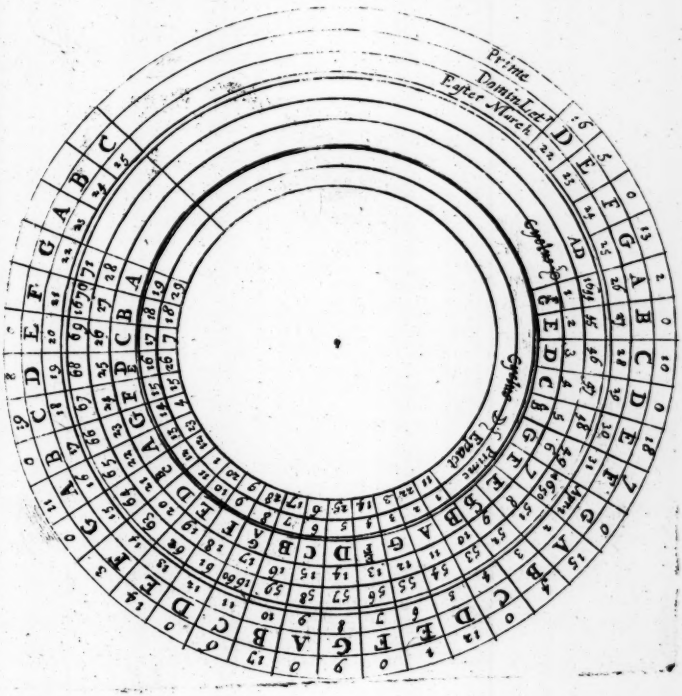
THough theſe Problemes cannot be performed by the Globe, becauſe of the ſeveral changes, and irregular accounts that their Rules are framed upon, yet becauſe they are of frequent and Vulgar uſe, and for that the ſolution of many other Queſtions will have dependency on the knowledge of theſe; Therefore I have thought fit here to inſert this Table of Mr. *Palmers*, by which you may find them All.

I ſhall not inſiſt upon the Reaſons of the ſeveral changes of Letters, and Numbers, Himſelf having already very learnedly handled that ſubject, in his Book of the *Catholick Planiſphear*, *Book* 1. *Chapter* 11. (to which I refer you) Neither ſhall I need to give you any other Inſtructions for finding what is here propoſed, then what himſelf hath given in his fourth *Book*, *Chapter* 66, and part of 67. Therefore take it as he there delivers it.

An Exam-

An Example ſhall ſerve here inſtead of a Rule. For the Year 1657. I would know all theſe: wherefore I ſeek the Year 1657. in the Table of the Suns Cycle, and over againſt it, I find 14. for the Year of the Cycle of the Sun, and D for the Dominical Letter. And note here that every Leap-year hath 2 Dominical Letters (as 1660 hath A G) and the firſt (*viz.* A) ſerveth that Year till *February* 25, and the ſecond (G) for the reſt of the Year. And note that theſe Letters go alwayes backwards when you count forwards (as B A, then G F, &c. not F G, and then A B) as you may ſee by the Table.

Then in the Table of the Cycle of the Moon, I have for the Year 1657. the Prime 5. the Epact 25. Thoſe had, I go to the Table for Eaſter, and ſeek there in the firſt rauck the Prime 5. and



under

under it in the middle rank ſtands E; that is not my Dominical Letter; therefore I ſeek not backward but alwayes forward in the middle rank till I come to my Dominical Letter D and under it I find in the third ranck *March* 29. upon which *Eaſter* day falls this Year 1657. The reſt of the moveable Feaſts may be had by their diſtances from *Eaſter* which are alwayes the ſame. Onely for *Advent Sunday*, remember that the next Sunday after *November* 26 is *Advent Sunday*. Read Book I. II. and that will ſufficiently inſtruct you with this Example.

To find the Age of the Moon.

Remember firſt that the Epact begins with *March*, which muſt be here accounted the firſt Moneth: Then if you add to the Epact the number of the Moneth current, and the number of the day of the Moneth current, the ſum or the exceſs above 30. is the Moons age.

Example, *January* 20 1656. According to the accompt of the Church of *England* (who begin the Year with *March* 25. which was the Equinoctial day about Chriſts time) the Epact is 14 *January* is the 11th Moneth. and the 20th day is propoſed; now add 14. 11. and 20. together, they make 45. out of which I take 30. and there remains 15. the Moons age.

PROB. LIV.

The Age of the Moon *given, to find her place in the* Ecliptick *according to her mean motion.*

THis Probleme may be performed exact enough for Common uſes by the Globe, but in regard it only ſhews the Moons place in the Ecliptick according to her mean motion, it will often fail you ſome few degrees of her true Place. The work is thus,

Firſt ſet figures to every twelfth degree of the Equinoctial, accounted from the Equinoctial Colure, marking them with 1, 2, 3. 4. &c. to 30 which will end where you began, *viz.* at the Equinoctial Colure again ſo ſhall the Equinoctial be divided into 30 equal parts repreſenting the 30. Dayes of the Moons Age. Theſe figures (to diſtinguiſh them from the degrees of the Equator) were beſt be writ with Red Ink.

When

When you would enquire the Moons Place, Elevate the North Pole 90 degrees, that is, in the Zenith, so shall the Equator ly in the Horizon: Then bring the Equinoctial Colure against the Day of the Moneth in the Horizon, so shall the Moons Age written in Red figures, stand against the Signe and degree in the Horizon that the Moon is in at that Time.

Example.

September 28. 1658. I would know the Moons place in the Ecliptick, she being then 12 Daies Old. Therefore I Elevate the North Pole 90 degrees above the Horizon, and turn the Globe about till the Equinoctial Colure come to *September* 28. in the Circle of Daies on the Horizon; then looking against what Signe and degree of the Ecliptick Circle in the Horizon the 12th division in Red figures stands, I find ♌ 9 which is the Sign and degree the Moon is in, according to her mean Motion.

This Probleme may be applyed to many Uses: for, having the Moons Place you may find the Time of her Rising, Southing, Setting, and Shining &c. by working with her, as you were taught to work with the Sun, in several fore-going Problemes, proper to each purpose.

PROB. LV.

Having the Longitude *and* Latitude, *or* Right Ascension *and* Declination *of any* Planet, *or* Comet, *to place it on the* Globe, *to correspond with its place in* Heaven.

PLanets and Comets cannot be placed on the Globe so as their places will long retain correspondence with their places in Heaven; Because as was said, Chap. 44. they have a continual motion from West to East upon the Poles of the Ecliptick: yet never-the-less you may by having their Longitude and Latitude, or Right Ascension and Declination, for any set Time, place a Mark for them on the Globe, either with Ink, if your Globe be Varnish, for then you may with a wet finger wipe it off again; or with Black-lead, if it be not Varnish, and then you may rub it out again with a little White

Bread: which Mark for that time, will as effectually ſerve you to work by, as any of the Fixed Stars placed on the Globe will do.

Therefore if the Longitude and Latitude of any Planet, or Comet, be given; Do thus, Elevate the North Pole, if the Latitude given be North; but if the Latitude given be South, Elevate the South Pole 66½ degrees; and place the Pole of the Ecliptick in the Zenith, and over it ſcrew the Quadrant of Altitude: ſo ſhall the Ecliptick ly in the Horizon; and the Quadrant of Altitude being turned about the Horizon ſhall paſs through all the degrees of Longitude; Then find the point of given Longiuude in the Ecliptick, and bring it to the Quadrant of Altitude and hold it there: Then count upwards on the Quadrant of Altitude the number of degrees and minures of given Latitude, and at the point where the number ends cloſe to the Quadrant of Altitude, make a ſmal Prick, and that Prick ſhall repreſent the Planet or Comet you were to place on the Globe.

If it be the Right Aſcenſion and Declination of a Planet or Comet that is given; you muſt find the degree and minute of Right Aſcenſion on the Equinoctial, and bring it to the Meridian, and keep the Globe there ſteddy; then find the degree and minute of Declination on the Meridian, and under that degree and minute on the Globe make a Prick, and that Prick ſhall repreſent the Planet, or Comet, as aforeſaid.

If it be ♄ or ♃ that this Prick is to repreſent, it may ſtand on the Globe ſomtimes a Week or a Fortnight, without much difference from the Planets place in Heaven. But if the Prick were to repreſent the other Planets, you muſt (in regard of their ſwift motion) alter it very often, eſpecially for the Moon; for ſo ſwift is her motion, that in every two hours ſhe alters about a degree in Longitude.

Having thus placed this Mark on the Globe, you may find out the Time of its ſeveral Poſitions, and Aſpects, if you work by it as you are directed to work by the Sun, in the ſeveral reſpective Problemes throughout this Book.

The End of the Second Book.

The Third BOOK.

Being the Practical Uſe of the

GLOBES.

Applyed to the Solution of *PROBLEMES* In the Art of NAVIGATION;

PRÆFACE.

BEcauſe the *Art of Navigation conſiſts aſwell in the knowledge of* Aſtronomical *and* Geographical Problemes, *as in Problemes meerly* Nautical; *Therefore I muſt deſire the Artiſt to ſeek in the laſt Book ſuch Problemes as are only* Aſtronomical *or* Geographical; *For my deſigne is here to collect ſuch Problemes as are only uſed in the Art of* Navigation: *ſome few particulars excepted, as for finding* Latitude, Longitude, Courſe, Diſtance &c. *Which though they are handled in that Book; yet for their Vtilitie in the Art of* Navigation, *and for that what there is given, cannot alwaies be had to work by; therefore in this Book I have mentioned divers other Obſervations, which being made or had, you may by the Rules proper for each Obſervation find what ſhall be propoſed.*

PROB. I.

The Suns Amplitude *and* Difference *of* Aſcenſion *given, to find the* Heigth *of the* Pole, *and* Declination *of the* Sun.

ELevate the Pole ſo many degrees as the Difference of the Suns Aſcenſion is, and ſcrew the Quadrant of Altitude to the Zenith, and bring the firſt point of ♈ to the Meridian, then number on the Quadrant of Altitude upwards the complement to 90. of the Suns Amplitude, and move the Quadrant of Altitude till that number of degrees cuts the Equator; So ſhall the Quadrant cut in the Horizon the degree of the Poles Elevation; and in the Equator the degree of the Suns Declination.

Example.

The difference of Aſcenſion is 27. degrees 7. minutes. Therefore I Elevate the Pole 27. degrees 7. minutes above the Horizon, and ſcrew the Quadrant of Altitude to 27. degrees 7 minutes, which is in the Zenith: then I bring the firſt point of ♈ to the Meridian, and number on the Quadrant of Altitude upwards 56. degrees 40. minutes, the Complement of the Suns Amplitude, and bring that degree to the Equator: then I ſee in what degree of the Horizon the Quadrant cuts the Horizon, and find 51 $\frac{1}{2}$, which is the Elevation of the Pole: then looking in what degree of the Equator the Quadrant of Altitude cuts the Equator, I find 20 degrees 5 minutes which is the Declination of the Sun at the ſame Time.

PROB. II.

The Suns Declination *and* Amplitude *given, to find the* Poles Elevation.

ELevate the Pole ſo many degrees as the Complement of the Suns Amplitude is; and ſcrew the Quadrant of Altitude

in

in the Zenith, and bring the first point of ♈ to the Meridian: Then count on the Quadrant of Altitude to the Degree of the Suns Declination, and bring that degree to the Equinoctial; and the degree of the Equinoctial cut by that degree of the Quadrant of Altitude, is the degree of the Poles Elevation.

Example.

The Suns Amplitude is 33. degrees 20. minutes, his Declination is 20. degrees 5. minutes, his Complement of Amplitude to 90. is 56. degrees 7 minutes. Therefore I Elevate the Pole 56. degrees 7. minutes above the Horizon, and screw the Quadrant of Altitude to 56. degrees 7. minutes which is in the Zenith: Then I bring the first point of ♈ to the Meridian, and number on the Quadrant of Altitude upward 20. degrees 5. minutes for the Suns Declination, this 20th degree 5. minutes, I bring to the Equinoctial, and find it cut there 51 ½. degrees, for the Height of the Pole.

PROB. III.

The Suns Declination *and* Hour *at* East *given, to find the* Heigth *of the* Pole.

ELevate the Pole so many degrees as the Suns Declination is, and screw the Quadrant of Altitude in the Zenith: Then convert the Hours or minutes past 6. given into degrees; by allowing 15. degrees for every Hour of Time, and for every minute of Time 15. minutes of a Degree; and number those degrees or minutes in the Horizon from the East Southwards; and bring the Quadrant of Altitude to that degree, so shall the Degree of the Quadrant of Altitude cut by the Equator be the Complement of the heigth of the Pole.

Example.

The Suns Declination is 20. degrees 5. minutes Therefore I Elevate the Pole 20. degrees 5. minutes, and also screw the Quadrant of Altitude to 20. degrees 5. minutes which is in the Zenith: the Hour the Sun comes to be at East is 7 a clock 7 minutes, that is, 1 Hour 7 minutes after 6. Therefore I convert 1 Hour 7 minutes

nutes into Degrees, as before, and it gives 16. degrees 50. minutes; which number of degrees and minutes I count from the Eaſt point Southwards, and thither I bring the Quadrant of Altitude: Then I look in what degree of the Quadrant of Altitude the Equator cuts, and find 38½, which is the Complement of the Poles Heigth, *viz.* 51½ degrees for the Heigth of the Pole.

In this Probleme the Declination of the Sun and Elevation of the Pole bears the ſame Denomination of either North or South, for when the Declination and the Elevation are different the Sun cannot come to the Eaſt point.

PROB. IIII.

The Declination *of the* Sun *and his* Altitude *at* Eaſt *given, to find the* Heigth *of the* Pole.

ELevate the Pole to the Complement of the Suns Altitude, and ſcrew the Quadrant of Altitude to the Zenith: Then bring the Equinoctial point ♈ to the Meridian, and number on the Quadrant of Altitude the degree of the Suns Declination, and bring that degree to the Equinoctial, and note the degree it cuts, for its Complement to 90 is the Heigth of the Pole.

Example.

May 10. The Suns Declination is 20. degrees 5. minutes; His Altitude at Eaſt is 25. degrees 55. minutes here at *London*: I enquire the Heigth of the Pole. Therefore I ſubſtract 25. deg. 55. min. from 90 the remains is 64. deg. 5. min. for its Complement, wherefore I bring 64. deg. 5. min. of the Meridian to the Horizon; and to 64. deg. 5. min. which is in the Zenith, I ſcrew the Quadrant of Altitude: then I bring ♈ to the Meridian, and count on the Quadrant of Altitude upwards 20. deg. 5. min. and move it about the Equinoctial till thoſe 20. deg. 5. min. touch the Equinoctial which I find to be in 38½ degrees, Therefore I ſubſtract thoſe 38½ from 90, and the remains is 51½ degrees. Therefore I ſay the Pole here at *London* is Elevated 51½ degrees.

The Declination and the Elevation is alwaies of the ſame Denomination North or South, for when they alter their Denominations the Sun at Eaſt can have no Altitude, neither can it indeed

reach

reach the East point: and therefore in this example, becaule the Suns Declination is North, it is the North Pole that is elevated.

To perform the ſame otherwiſe, with a pair of Compaſſes.

Take off with your Compaſſes from the Equator or Quadrant of Altitude the number of degrees of Altitude obſerved, and place one foot at the beginning of ♈ on the inner edge of the Horizon, and extend the other directly upwards towards the *Zenith*: Then move the Brazen Meridian through the notches of the Horizon till the other point of your Compaſſes (reſpecting the *Zenith*) reach the parallel of the Suns Declination: So ſhall the number of degrees on the Meridian be the number of degrees that the Pole is elevated above the Horizon; and is either North or South according as the Suns Declination is: as before.

This may yet otherwiſe be performed with the Quadrant of Altitude, by taking the Nut off the Meridian, and laying the edge of its Index (ſpecified in Chap. 1. Sect. 6. of the firſt Book) exactly on the Eaſt line of the Horizon: for when that lies ſtraight between the point of Eaſt on the outter verge of the Horizon and the beginning of ♈ in the inner verge of the Horizon, then ſhall the upper end of the Quadrant of Altitude point directly to the *Zenith*: and if then you turn the Meridian through the notches of the Horizon till the Suns Altitude on the Quadrant of Altitude cuts the parallel of Declination, you will have the end of the Quadrant of Altitude on the Meridian point to the heigth of the Pole: as before.

PROB. V.

By the Suns Declination *and* Azimuth *at 6 of the Clock given, to find the Heigth of the* Pole, *and* Almicantar *at ſix.*

ELevate the Pole ſo many degrees as the Suns Azimuth is at 6. and ſcrew the Quadrant of Altitude in the Zenith, and bring the firſt point of *Aries* to the Meridian: Then number on the Quadrant of Altitude upwards the complement of the Suns Declination, and bring that degree to the Equator: So ſhall the degree

degree of the Horizon cut by the Quadrant of Altitude be the complement of the Poles Elevation; and the degree of the Equatōr cut by the Quadrant of Altitude shall be the Almicantar of the Sun at 6. of the clock.

Example.

The Suns Azimuth at 6 is 12¼ degrees: Therefore I elevate the Pole 12 ¼, and screw the Quadrant of Altitude to 12 ¼ degrees which is in the Zenith: then I bring the first point of *Aries* to the Meridian; The Suns Declination is 20 deg. 5 min; Therefore I number on the Quadrant of Altitude 69 deg. 55 min. which is the complement of 20 deg. 5 min. to 90. this 69 deg. 55 min. on the Quadrant of Altitude I bring to cut the Equator, and find when 69 deg. 55 min. cuts the Equator, that the Quadrant of Altitude cuts the Horizon in 38 ½ deg. which is the complement of the Poles Elevation: and at the same time the Quadrant of Altitude also cuts the Equator in 15 ½ degrees; which is the Almicantar or Altitude of the Sun at 6 a clock.

PROB. VI.

The Day *of the* Moneth *and* Hour *of the* Night *given, to find the* Heigth *of the* Pole, *by a known* Star *observed* Rising *or* Setting.

REctifie the Hour-Index, by Prob 2 of the former Book; and turn the Globe Westwards till the Hour-Index points at the Hour of the Night; fasten the Globe there, and turn the Meridian through the notches of the Horizon till the known Star come to the East side the Horizon, if the Star be Rising, or the West if it be Setting; so shall the degrees of the Poles Elevation be cut by the Horizon under the elevated Pole; and is North or South according as the elevated Pole of the Globe is.

PROB. VII.

Two Places *given in the same* Latitude, *to find the* Difference *of* Longitude.

BRing the first Place to the Meridian, and note the number of degrees of the Equinoctial that comes to the Meridian with

with it; then Bring the other place to the Meridian, and note the number of degrees of the Equator that comes to the Meridian with it: and by ſubſtracting the leſſer number from the greater you have the difference of Longitude. This needs no Example.

PROB. VIII.

Two Places given in the ſame Longitude, *to find the Difference of* Latitude.

BRing the Places to the Meridian, and the degrees of the Meridian over the two Places is the Latitudes of them both: and by ſubſtracting the leſſer number of degrees from the greater you will have the difference of Latitude.

PROB. IX.

Courſe *and* Diſtance *between two Places given, to find their Difference in* Longitude *and* Latitude.

SEek the Rhumb you have ſailed upon, as in Prob. 34. of the laſt Book, and upon that Rhumb make a mark for the Place you departed from; then with your Compaſſes take off from the Equinoctial the number of Leagues you have ſailed upon that Rhumb, by allowing a degree for every 20. Leagues, and place one foot of your Compaſſes upon that mark, and where the other foot falls on that Rhumb make a ſecond mark; then by bringing the firſt mark to the Meridian, you will ſee on the Meridian the Latitude of that mark, and in the Equator the Longitude as in Prob. 2. of the laſt Book: and by bringing the ſecond mark alſo to the Meridian, you will as before, find the Longitude and Latitude of the ſecond mark alſo. Then by ſubſtracting the leſſer Latitude from the greater Latitude, and the leſſer Longitude from the greater Longitude, you will have the difference remaining, both of Longitude and Latitude you are arived into.

PROB. X.

To find how many Miles are contained in a Degree of any Parallel.

EVery Degree of the Equinoctial contains 20. Englisſh Leagues, and every League 3. Englisſh Miles: But in every Parallel to the Equinoctial the Degrees diminiſh more and more even to the Pole, where they end in a point. Therefore a Degree in any Parallel cannot contain ſo many Miles as a Degree in the Equinoctial. Now that you may know how many Miles are contained in a Degree of any Parallel to the Equinoctial. Do thus, Meaſure with your Compaſſes the width of any number of Degrees in any given Parallel; ſuppoſe (for Example ſake) 10. Degrees in the Parallel of 51½; Examine in the Equator how many Degrees of the Equator they will make, and you will find 6 ⅕. Therefore 1. Degree in the Equator making 60 Miles, 6. Degrees makes 360. to which add for the ⅕ part 12 Miles, makes 372 Miles, to be the Meaſure of 10 Degrees in the Parallel of 51 ½. So that by dividing 372. by 10. you have 37 Miles for the length of a Degree, from Eaſt to Weſt in the Parallel of 51 ½ Degrees.

PROB. XI.

The Rhumb *you have ſailed upon, and the* Latitudes *you departed from, and are arrived to, given, to find the* Difference *of* Longitude, *and the number of Leagues you have Sailed.*

FIrſt ſeek the Rhumb you have ſailed on, and paſs it through the Meridian till it cuts in the Meridian the Latitude you departed from; and keeping the Globe there ſteddy make a mark cloſe by the Meridian, under that Latitude and in that Rhumb on the Globe, and note in the Equinoctial the degree of Longitude at the Meridian: then paſs that Rhumb through the Meridian again, till it cuts in the Meridian the Latitude you are arrived to; and in that Rhumb and Latitude make on the Globe another mark, and examine in the Equinoctial the

the Longitude of the ſecond mark; for the difference between the firſt and ſecond mark, is the difference of Longitude; Then open your Compaſſes to one Degree of the Equinoctial, and by meaſuring along in the Rhumb, count how many times that Diſtance is contained between the two points in that Rhumb; for ſo many times 20. Leagues is the Diſtance you have ſailed.

Example.

I ſail upon the North Weſt Rhumb from the Latitude of 10. degrees, into the Latitude of 30. degrees 40. minutes. Therefore I find the North Weſt Rhumb, and turn the Globe through the Meridian till this Rhumb cut the Meridian in the firſt Latitude, *viz.* in 10. degrees, and directly under 10. degrees upon the Rhumb I make a prick, and alſo find 10. degrees 3. minutes, of the Equator at the Meridian, for the Longitude of the Firſt Place. Then I turn the Globe again through the Meridian, till the ſame Rhumb cut the Meridian in the ſecond Latitude, *viz.* in 30. degrees 40. minutes, and directly under thoſe 30. degrees 40. minutes in the ſame Rhumb, I make another prick, which repreſents the Place I am arrived to: I examine the Longitude of this prick, as before, and find it 32. degrees 10. minutes. Therefore I ſubſtract the firſt Longitude, *viz.* 10. degrees 3. minutes from the ſecond Longitude, *viz.* 32. degrees 10. minutes, and there remains 22. degrees 7. minutes, for the Difference of Longitude.

Then for examining the Diſtance, I open my Compaſſes to 1. degree on the Equinoctial and meaſure upon the Rhumb how oft that Diſtance is contained between the two pricks, and find 29¼, that is, 29. degrees 15. minutes, which multiplyed by 20. gives 585. for the number of Leagues ſailed upon that Rhumb.

The reaſon why I open the Compaſſes no wider then to 1. degree, is becauſe the Rhumbs being Circular or crooked lines the diſtance on them may be meaſured more exactly by often counting that 1. degree in them than if the Compaſſes had bin opened to many degrees. Thus if the Compaſſes had been opened wide enough to reach between the two pricks aforeſaid, I ſhould not have had above 583. Leagues for the diſtance between the two places: neither is there indeed more great Circle diſtance between them; But I ſailed upon a Rhumb, that is, I follow'd

the Courſe of a Circular winding line, and ſo fetcht a Compaſs about to come to theſe two pricks; and therefore I have in truth ſailed 585. Leagues. For the ſegment of a Rhumb between two Places is alwaies greater then a ſtraight line drawn betwixt them; yea ſometimes by half or more in Places neer either Pole.

Note, If you be not very curious in opening your Compaſſes to this ſmal diſtance, you may in oft turning them about upon the Rhumb commit error in your meaſuring: therefore when you have taken the Diſtance of one degree, try if you neither gain or looſe any thing in meaſuring 10, or 20. degrees of the Equinoctial by them: for then your Compaſſes are opened to a width exact enough for your purpoſe.

PROB. XII.

The Longitude *and* Latitude *of two Places given, to find* Courſe, *and* Great Circle *diſtance between them.*

FInd on the Globe the Longitudes and Latitudes given, and make pricks to either Longitude and Latitude: If any Rhumb paſs from one place to the other, that is (without more adoe) the Rhumb ſought. But if no Rhumb paſs through; Take the Rhumb that runs moſt Parallel to the two pricks: for that ſhall be the Rhumb, or the neereſt Rhumb that theſe two pricks Bear on. An Example of this, ſee in Prob. 34. of the laſt Book: And the Great Circle Diſtance between theſe two pricks, you may find as by Prob. 33. of the ſame Book.

PROB. XIII.

The Latitude *you departed from, and the* Latitude *you are arrived to, and the number of Leagues you have ſailed given, to find the* Rhumb *you have ſailed on, and difference of* Longitude.

MAke a prick on the Globe in the Latitude you departed from: then open your Compaſſes to the number of Leagues you have ſailed, by taking for every 20. Leagues 1. degree of the Equator, half a degree for

10.

10. Leagues, a quarter of a Degree for 5. Leagues, and ſo proportionably for any other number of Leagues: Place one foot of your Compaſſes in the prick made for the Latitude you departed from, and extend the other towards the Latitude you are arrived to, and deſcribe an occult Arch; Turn the Globe till this occult Arch come to the Latitude on the Meridian, and where the Latitude cuts this occult arch make another prick to repreſent the Latitude you are arrived to; ſo ſhall the Rhumb paſſing through thoſe two pricks (or that is moſt Parallel to thoſe two pricks) be as in the laſt Prob. the Courſe or the Rhumb thoſe two pricks Bears on.

The difference of Longitude you may find as by Prob. 11.

PROB. XIV.

To find by the Globe the Variation of the Needle; *commonly called the* Variation of the Compaſs.

OBſerve by a Compaſs whoſe wyer is placed juſt under the Flower deluce, what point of the Compaſs the Sun Riſes or Sets on, Morning, or Evening: Then examine by Prob. 10. of the ſecond Book, what degree of the Horizon the Sun Riſes or Sets on by the Globe alſo; and if the Riſing or Setting be the ſame, both on the Globe and Compaſs, there is no Variation in your Place, But if there be difference between the Riſing or Setting by the Compaſs and the Globe, then is there Variation in your Place.

If the point the Sun Riſes upon in the Compaſs be neerer the North point, than the point the Sun Riſes upon by the Globe, the Variation is Weſtwards.

If the point the Sun Sets upon in the Compaſs be neerer the North than the point it Sets upon by the Globe, the Variation is Eaſtwards.

If the point the Sun Sets upon in the Compaſs be further from the North point, than the point the Sun Sets upon by the Globe, the Variation is Weſtward.

If the point the Sun Riſes upon in the Compaſs be further from the North point than the point the Sun Riſes upon by the Globe, the Variation is Eaſtwards. And ſo many degrees as there is between the point of Riſing or Setting found by the Compaſs, and the point of true Riſing or Setting found by the Globe, ſo

many degrees is the Variation from the North towards the East or Weſt point.

Otherwiſe, when the Sun hath Altitude.

Having the Altitude of the Sun; find by Prob. 22. of the ſecond Book, its Azimuth: Then examine by a Compaſs whether the true Azimuth found by the Globe, agree with the Azimuth found by a Nautical Compaſs: If they agree there is no Variation: But if the Azimuth of the Compaſs before Noon be neerer the North than the true Azimuth found by the Globe, the Variation is Weſtwards.

If the Azimuth by the Compaſs Afternoon he neerer the North, the Variation is Eaſtwards.

If the Azimuth by the Compaſs Afternoon be further from the North, the Variation is Weſtwards.

If the Azimuth by the Compaſs before Noon be further from the North the Variation is Eaſtwards.

And this Variation ſhall be as aforeſaid ſo many degrees as there is betwen the Azimuth Obſerved by the Compaſs, and the true Azimuth, Obſerved by the Globe.

PROB. XV.

To keep a Journal *by the* Globe.

BY ſome of theſe foregoing Problemes you may Dayly (when Obſervations can be made) find both the Longitude and Latitude on the Globe of the Places you are arived to, and alſo the Way the Ship hath made, and make pricks on the Globe in their proper Places for every Daies Voyage, ſo truly and ſo naturally that if you kept your reckonig aright you may be ſure you cannot miſs any thing of the truth it ſelf; and that with leſs trouble and greater advantage, then keeping a Book of every Daies Reckoning.

PROB. XVI.

To Steer *in the* Night *by the* Stars.

REctifie the Globe and Hour Index as by Prob. 2. of the laſt Book, and trun about the Globe till the Index of the Hour Circle points to the Hour of the Day or Night; Then turn the Globe till the Difference of Longitude between the Place you depart from, and the Place you ſail to paſs through the Meridian; and if any Star in the Latitude of the Place you ſail To come to the Meridian, or neer the Meridian with the degree of the difference of Longitude, that Star is at that time in or neer the Zenith of that Place you ſail to: and by finding the ſame Star in Heaven, as by Prob. 44. of the laſt Book, you may direct your Ship towards that Star and ſail as confidently ſaies (Mr *Blagrave*) as if *Mercurie* were your Guide. But becauſe this Star moves from the Zenith of this Place you muſt often examine what Star is come to the Zenith, and ſo often change the Star you Steer by, as the length of your Voyage may require.

PROB. XVII.

How to platt on the Globe New Land, *never before Diſcovered.*

THeſe two following Problemes are 2. Chapters of Mr *Wrights*, delivered by him as follows.

It may ſomtimes fall out in new Diſcoveries, or when your Ship by meanes of a Tempeſt is driven out of her right Courſe, that you ſhall come to the ſight of ſome Iſle Shoal or new Land whereof the Mariner is utterly ignorant: And to make ſome relation of the ſame or go unto it ſome other time if you deſire to ſet it down on your Globe in the true place, you may do it after this manner: So ſoon as you have ſight thereof, mark it well firſt with your Compaſs, obſerving diligently upon which Point thereof it lieth, And ſecondly, you muſt there take the height of the Sun, or of the Pole-ſtar, as you were taught Prob. 13, of the ſecond Book, that you may know

in

in what Point your Ship is, and that point you muſt call the Firſt Point; which being ſo done your Ship may ſail on her Courſe all that day, till the day following, without loſing her Way: and the next day mark the Land again; and ſee upon what Point it lieth; and then take your heigth, and with it caſt your Point of Traverſe once again, and that you may call your ſecond Point Then take a pair of Compaſſes, and placing one foot upon the firſt Point, and the other upon the Rhumb towards which the Land did Bear when you Caſt your firſt Point; ſet alſo one foot of another pair of Compaſſes, in the ſecond Point, and the other foot upon the Rhumb upon which the Land lay when you caſt your ſecond Point; and theſe two Compaſſes thus opened, you muſt move by their Rhumbs, till thoſe two feet of both Compaſſes do meet together, which were moved from the foreſaid two Points: and where they do ſo meet together, there may you ſay is the Land which you diſcovered; which Land you may point out with the In-lets and Out-lets, or Capes, and other Signes, which you ſaw thereupon. And by the graduation you may ſee the Latitude thereof, that thereby you may find it, if at any time after you go to ſeek for it.

PROB. XVIII.

Seeing two known Points *or* Capes *of Land, as you ſail along, how to know the diſtance of your Ship from them.*

PItch one foot of one pair of Compaſſes upon one of the two foreſaid Capes, and the other foot upon the Rhumb which in this Compaſs pointeth towards that Cape: And in like manner ſhall you do with another pair of Compaſſes, placing one foot thereof upon the other known Cape, and the other foot upon the Rhumb, which ſtretched towards the ſaid ſecond Cape; and moving the two Compaſſes (ſo opened) by theſe two Rhumbs off from the Land, the very ſame Point where the two feet which came from the two Capes do meet, you may affirm to be the very Point where your Ship is; And then meaſuring by the degrees of the Equinoctial, you may ſee what diſtance there is from the ſaid Point to either of the foreſaid Capes, or to any other place, which you think good; for it is a very eaſie matter, if you know the point where your Ship is.

PROB.

PROB. XIX.

Of Tides, *and how by help of the* Globe *you may in general judge of them.*

DIvide the Equinoctial into 30 equal parts, as was directed in Prob. 54. of the laſt Book. Theſe 30. equal parts repreſent the 30. Daies of the Moons Age.

Then on the North and South points of the Compaſs in the outmoſt Verge of the Horizon, write With red Ink 12. From the North Eaſtward, *viz.* at the Point North and by Eaſt, write $11\frac{1}{4}$. At the next point to that the ſame way, *viz.* North North Eaſt, Write $10\frac{1}{2}$. At the next, *viz.* North Eaſt and by North, Write $9\frac{3}{4}$ And ſo forward to every point of the Compaſs; rebating of the laſt hour $\frac{1}{4}$ till you come to 12, in the South; where you muſt begin again to mark that Semi-circle alſo in the ſame order you did the laſt. In this Circle is then repreſented the Points of the Compaſs the Sun and Moon paſſeth by every Day; and the Figures annexed repreſent the twice 12. hours of Day and Night.

Having thus prepared your Globe and Horizon, you may by having the Moons Age, and the point of the Compaſs on which the Moon maketh full Sea at any Place given, find at what Hour of Day or Night it ſhall be high Tide in the ſame Place. Thus,

It is a known Rule that a North and South Moon makes high water at *Margarete*. Therefore Bring the firſt point of ♈ to the North or South point in the Horizon, and Elevate the North Pole into the Zenith: Then count in the Equinoctial, the Daies of the Moons Age numbred in red figures; and the Hour and minutes written in red figures annexed to the names of the Winds that ſtands againſt the Moons Age ſhall be the Hour of High Tide on that Day or Night at *Margarete*.

The End of the Third Book.

The Fourth BOOK,

Shewing the Practical Uſe of the

GLOBES.

Applying them to the Solution of

Aſtrological Problemes.

PRÆFACE.

THe *Practiſe of* Aſtrology *is grounded upon a two-fold Doctrine. The firſt, for erecting a Figure of Heaven, placing the Planets in it, finding what Aſpects they bear each other, and in what Places they are conſtituted, &c. and this we call the* Aſtronomical *part of* Aſtrology.

The ſecond is, how to judge of the events of things by the Figure erected: and this is indeed the only Aſtrological *part.*

The firſt of theſe I ſhall briefly handle; becauſe what therein is propoſed may be performed by the Globe, both with ſpeed, eaſe, delight, and demonſtration. The ſecond I ſhall not meddle with, but refer you to the whole Volumnes already written upon that Subject.

PROB.

PROB. I.

To Erect a Figure of the 12 Houſes *of* Heaven.

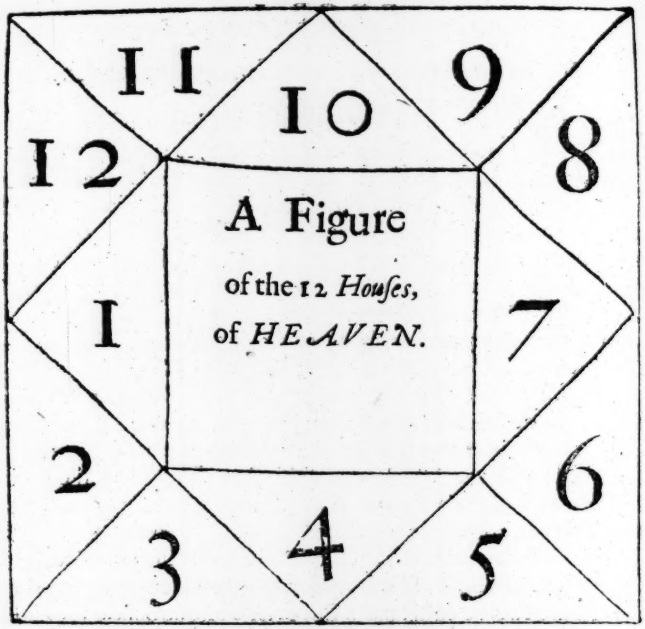
BEfore you erect a Figure of the 12 Houſes of Heaven it will be requiſite you place the Planets, ☊ and ☋ according to their Longitude and Latitude upon the Globe, as was directed Prob. 55. of the ſecond Book: for then, as you divide the Houſes of your Figure by the Circle of Poſition, you may by inſpection behold in what Houſes the Planets are ſcituated, and alſo ſee what fixed Stars they are applying to, or ſeparating from. But to the matter.

There is diſagreement between the Ancient and Modern Aſtrologers, about erecting a Figure of Heaven. Mr *Palmer* in his Book of *Spherical Problemes* Chap. 48. mentions four ſeveral waies, and the Authors that uſed them: whereof one of them is called the *Rational way* uſed by *Regiomontanus*; and now generally practiſed by all the Aſtrologers of this Age. This way the face of Heaven is divided into twelve parts, which are called the twelve Houſes of Heaven, numbred from the Aſcendent or angle at Eaſt downwards, with 1, 2, 3, &c. As in the following Figure.

In a Direct Sphear, *viz.* under the Equator theſe twelve Houſes are twelve equal parts: But in an Oblique Sphear they are unequal parts, and that more or leſs according to the quantity of the Sphears obliquity.

Theſe twelve Houſes are divided by 12. Semi-Circles of Poſition; which are Semi-Circles paſſing from the two interſections of the Horizon and Meridian through any Star, degree or point in the Heavens.

Four of theſe Houſes are named Cardinals. The firſt and moſt eminent of theſe Cardinals is the firſt Houſe, or Angle of Eaſt called the Aſcendent; where the Semi-Circle of poſition is the ſame with the Eaſtern Semi-Circle of the Horizon. The ſecond Cardinal is the tenth Houſe or the Angle of South; called *Medium Cæli* or *Culmen Cæli*; where the Semi-Circle of Poſition is the ſame with the Semi-Circle of the Meridian above the Horizon. The third Cardinal is the ſeventh Houſe, or the Angle of Weſt; called the Deſcendent, where the Semi-Circle of Poſition is the ſame with the Weſtern Semi-Circle of the Hori-



zon. The fourth Cardinal is the fourth Houſe, or Angle of North; called *Imum Cœli*; where the Semi-Circle of Poſition is the ſame with the Semi-Circle of the Meridian under the Horizon.

The degrees and minutes of the Ecliptick upon the Cuſps of theſe four Houſes (that is, upon the beginning of theſe Houſes) are found all at once; only by bringing the Riſing degree of the Ecliptick to the Horizon: (for the Horizon repreſents the Cuſp of the Aſcendent:) and then ſhall the Meridian cut the degree of the Ecliptick on the Cuſp of the tenth Houſe. The Weſtern Semi-Circle of the Horizon ſhall cut the degree of the Ecliptick on the Cuſp of the Seventh Houſe: and the Semi-Circle of the Meridian under the Horizon ſhall cut the degree of the Ecliptick on the Cuſp of the fourth Houſe.

If you have the day of the Moneth you may by Prob. 3. of the

the ſecond Book find the Suns Place; and if you have the Hour of the Day you may, by firſt rectifying the Globe, as by Prob. 2. of the ſame Book, turn about the Globe till the Index of the Hour-Circle point to the ſame Hour in the Hour-Circle, and you will then at the Eaſtern Semi-Circle of the Horizon have the degree of the Ecliptick that is Riſing, and by Conſequence (as aforeſaid) all the Cardinal points in their reſpective places.

Now to find what degree of the Ecliptick occupies the Cuſps of the other eight Houſes of Heaven; Do thus, The Globe rectified, as aforeſaid, Move the Semi-Circle of Poſition upwards till 30. degrees of the Equator ſhall be contained between it and the Eaſtern Semi-Circle of the Horizon; ſo ſhall the Semi-Circle of Poſition cut in the Ecliptick the degree and minute of the Ecliptick on the Cuſp of the twelfth Houſe; and its oppoſite degree and minute in the Ecliptick ſhall be the Cuſp of the ſixth Houſe, (for you muſt note that if you have but the degree and minute of the Ecliptick upon the Cuſps of ſix of the Houſes, the oppoſite degrees and minutes of the Ecliptick ſhall immediately poſſeſs the Cuſp of every oppoſite Houſe.)

Then move the Circle of Poſition over 30 degrees more of the Equinoctial, ſo ſhall the degree of the Ecliptick cut by the Circle of Poſition be the degree of the Ecliptick upon the Cuſp of the eleventh Houſe; and its oppoſite degree in the Ecliptick ſhall be upon the Cuſp of the fifth Houſe. The degree of the Ecliptick upon the Cuſp of the tenth and fourth Houſes was found as before. Then remove the Circle of Poſition to the Weſtern ſide of the Meridian, and let it fall towards the Horizon till 30. degrees of the Equator are contained between the Meridian and it, ſo ſhall the degree of the Ecliptick cut by the Semi-Circle of Poſition be the degree of the Ecliptick on the Cuſp of the Ninth Houſe; and the oppoſite degree of the Ecliptick ſhall be upon the Cuſp of the third Houſe. Let the Semi-Circle of Poſition fall yet lower, till it paſs over 30. degrees more of the Equator, ſo ſhall the degree of the Ecliptick cut by the Semi-Circle of Poſition be the degree of the Ecliptick on the Cuſp of the eighth Houſe; and the oppoſite degree of the Ecliptick ſhall be upon the Cuſp of the ſecond Houſe. The degrees of the Ecliptick on the Cuſp of the ſeventh Houſe, and Aſcendent were found as before.

Example.

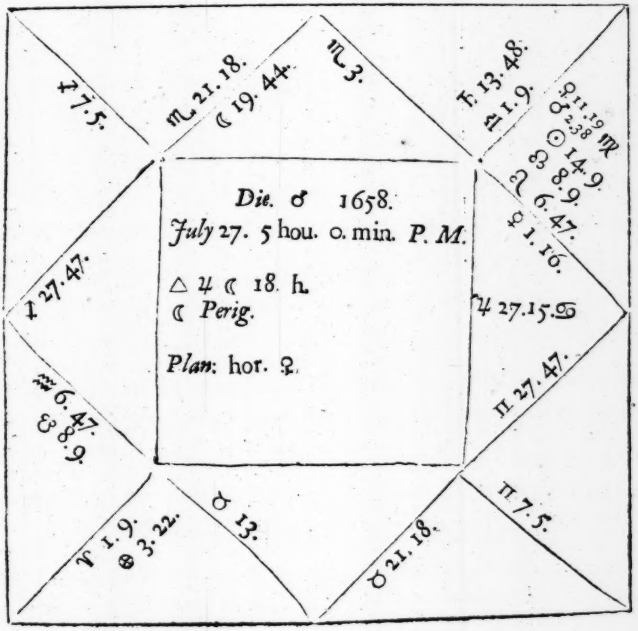
I would erect a figure of Heaven for *July* 27. 5. hours 0. minutes Afternoon, 1658. in the Latitude of *London*, *viz.* 51½. degrees, North Latitude.

I firſt place the Planets, ☉, and ☋, on the Globe, as by Prob. 55. of the ſecond Book was directed: yet not exactly as I find them in the Ephemeris, for that ſhews only their place in the Ecliptick at Noon: Therefore I conſider how many degrees or minutes each Planets motion is in a whole Day or 24. Hours, by ſubſtracting the Ecliptical degrees and minutes of the Planets place that Day at Noon from the Ecliptical degrees and minutes of the Planets place the next Day at Noon: or contrarily if the Planets be Retrograde: for the remains of thoſe degrees and minutes is the motion of the Planet that Day; Therefore proportionably to that motion I place the Planet forward in the Ecliptick: (or backwards if it be Retrograde:) As if the Sun ſhould move forwards 1. degree, that is 60. minutes in a whole Day, or 24 Hours, then in 12 Hours he ſhould move 30. minutes, in 6 Hours 15. minutes, in 4 Hours 10. minutes, in 1 Hour 2½ minutes, and ſo proportionably for any other ſpace of Time: which I conſider before I place the Planets on the Globe.

Having thus placed the Planets on the Globe, I Elevate the North Pole 51½. degrees above the Horizon, and find the Suns place by Prob. 3. Book 2. to be in ♌ 14. degrees 9. minutes, Therefore I bring ♌ 14. degrees 9. minutes to the Meridian, and the Index of the Hour-Circle to 12. Then I turn the Globe Weſtward, becauſe it is Afternoon, till the Index point to 5. Hours afternoon, and with a quill I faſten the Globe in this Poſition: Then I examine what degree of the Ecliptick is at the Aſcendent or Horizon, and find ♐ 27. 47. to which Signe degree and minute ♊ 27. 47. is oppoſite, and therefore, as aforeſaid upon the Cuſp of the Seventh Houſe: Lifting up the Circle of Poſition till it paſs over 30. degrees of the Equator from the Horizon upwards I find ♐ 7. 5 cut by it in the Ecliptick, which is the Signe degree and minute upon the Cuſp of the twelfth Houſe, and its oppoſite Signe degree and minute is ♊ 7. 5. which is upon the Cuſp of the ſixth Houſe: Then lifting up the Circle of Poſition again till it paſs over 30. degrees more of the Equinoctial, I find

cut

cut by the Circle of Position ♏ 21. 18. which is the Signe degree and minute upon the Cusp of the eleventh House; and its opposite Signe degree and minute is ♉ 21. 18. which is upon the Cusp of the fifth House: ♏ 3. 20. is at the Meridian, which is the Cusp of the tenth House, and the Signe degree and minute opposite to it is ♉ 3. 20. which is on the Cusp of the fourth House. Then taking the Semi-Circle of Position off its Poles, I place it on the West side the Meridian, and let it fall towards the Horizon till it pass over 30. degrees of the Equator from the Meridian, and find the Circle of Position cut the Ecliptick in ♎ 1. 9. which is the Signe degree and minute on the Cusp of the ninth House; opposite to ♎ 1. 9. is ♈ 1. 9. therefore ♈ 1. 9. is upon the Cusp of the third House: Letting the Circle of Position fall yet lower till it passes over 30. degrees more of the Equator, I find it cut the Ecliptick in ♌ 6. 47. which is the Signe degree and minute up-



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on the Cuſp of the eighth Houſe; and its oppoſite Signe degree and minute is ♒ 6, 47. which is upon the Cuſp of the ſecond Houſe; So have you a Figure of the face of Heaven; which if you have future uſe for, you may ſet down the ſeveral characters in the proper places of a Figure, as they are on the other ſide the leaf.

PROB. II.

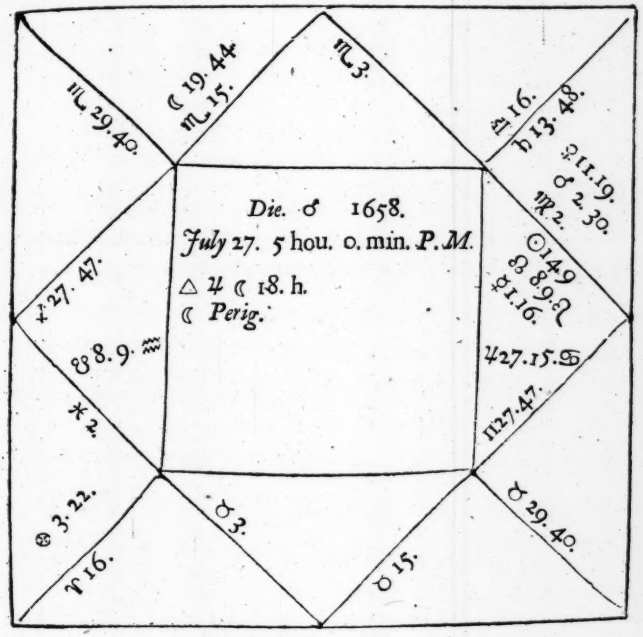
To Erect a Figure of Heaven *according to* Campanus.

Regiomontanus as aforeſaid makes the beginnig of every Houſe to be the Semi-Circle drawn by the ſide of the Semi-Circle of Poſition according to the ſucceſſion of every 30th degree of the Equator from the Horizon. But *Campanus* makes it to be the Semi-Circle drawn by the ſide of the Semi-Circle of Poſition according to the ſucceſſion of every 30th degree of the *Prime Verticle* or Eaſt *Azimuth*; which is repreſented by the Quadrant of Altitude placed at the Eaſt point.

The four Cardinals are the ſame both according to *Regiomontanus* and *Campanus* but the other eight Houſes differ. Therefore when you would find them according to *Campanus*; Rectifie the Globe and Quadrant of Altitude, and bring the lower end of the Quadrant of Altitude to the Eaſt point in the Horizon: then count from the Horizon upwards 30. degrees on the Quadrant of Altitude, and bringing the Circle of Poſition to thoſe 30 degrees examine where the Circle of Poſition cuts the Ecliptick; which at the aforeſaid time is in ♏ 29. 40. for that degree and minute is upon the Cuſp of the twelfth Houſe, and its oppoſite degree and minute in the Ecliptick *viz.* ♉ 29. 40. is upon the Cuſp of the ſixth Houſe: Lift up the Circle of Poſition 30 degrees higher upon the Quadrant of Altitude (*viz.* to 60. degrees) and the Circle of Poſition will cut the Ecliptick in ♏ 15. degrees for the Cuſp of eleventh Houſe. and its oppoſite degree and minute in the Ecliptick *viz.* ♉ 15. is upon the Cuſp of the fifth Houſe. The degree and minute of the Ecliptick on the Cuſp of the Tenth and fourth Houſes is at the Meridian.

Then tranſfering the Circle of Poſition to the Weſt ſide of the Meridian and the Quadrant of Altitude to the Weſt point in the Horizon; Let the Semi-Cirlce of Poſition fall 30 degrees from the Meridian on the Quadrant of Altitude, and it will cut in the Ecliptick

cliptick ♎ 16 degrees, for the Cuſp of the ninth Houſe, and its oppoſite degree and minute in the Ecliptick *viz.* ♈ 16 is upon the Cuſp of the third Houſe: Let fall the Circle of Poſition 30 degrees lower on the Quadrant of Altitude, and it will cut the Ecliptick in ♍ 2 degrees for the Cuſp of the eighth Houſe, and its oppoſite degree *viz.* ♓ 2. degrees is on the Cuſp of the ſecond Houſe: The Cuſps of the Seventh and Aſcendent is the ſame with *Regiomontanus viz.* ♊ 27. 47. and ♐ 27. 47. The Figure follows.



PROB. III.

To find the length of a Planetary Hour.

Aſtrologers divide the Artificial day (be it long or ſhort) into 12 equal parts, and the Night into 12 equal parts: Theſe parts they call Planetary Hours. The

firſt of theſe Planetary Hours takes its denomination from the Planetary Day; and the reſt are named orderly from that Planet according to the ſucceſion of the Planetary Orbs As if it be Munday, that is, the Moons day, (as by Prob. 42, of the ſecond Book,) the Planet reigning the firſt Hour ſhall be ☾, the Planet ruling the ſecond Hour ſhall be ♄, the third Planetary Hour ſhall be ♃, the fourth ♂, the fifth ☉, the ſixth ♀, the ſeventh ☿: Then begin again with ☾ for the eighth Planetary, ♄ for the ninth and ſo through the whole Day and Night, till the Sun Riſe again the next Day.

The length of this Planetary Hour is found by the Globe, thus, The Globe rectified; Bring the Suns place to the Eaſt ſide the Horizon, and make a prick at the degree of the Equator that comes to the Horizon, with it. Then remove the Suns place to the Meridian, and count the number of degrees of the Equator comprehended between that prick and the degree now at the Horizon; and divide that number of degrees and minutes by 6. becauſe there is 6 Planetary Hours paſt ſince Noon; and the Quotient ſhall ſhew the number of degrees and minutes that paſs through the Meridian in one Planetary Hour.

Example.

July 27. I would know the length of a Planetary Hour here at *London*: I Rectifie the Globe, and bring the Suns place *viz.* ☌ 13 50. to the Eaſtern ſide the Horizon, and find 115 degrees of the Equator come to the Horizon with it; to this 115 degrees I make a prick: Then I turn the Suns place to the Meridian, and find 226 degrees of the Equator at the Horizon, Therefore I either count the number of degrees between the pricks and the degree of the Equator at the Horizon, or elſe ſubſtract the leſſer from the greater, but both waies I find 111 degrees of the Equator to paſs through the Meridian (or the Horizon) in ſix Planetary Hours: Therefore dividing 111. by 6. I find 18. deg. 30 min. of the Equator to paſs through the Meridian in one Planetary Hour; which 18 degrees 30 minutes reduced into Time, yeelds 74. minutes by accounting for every 15 degrees one Hour, for 1. degree 4 minutes, and for half a degree 2. minutes of Time, and ſo proportionably; ſo that the length of a Planetary Hour, *July* 27 is 1 common Hour and 14 minutes here at *London*.

PROB.

PROB. IV.

The length of a Planetary Hour *known, to find what* Planet *Reigneth any given* Hour *of the Day or* Night.

THe Globe rectified as in the laſt Probleme, Turn about the Globe till the Index of the Hour-Circle points to the Hour of the Day in the Hour-Circle. Then count the number of degrees comprehended between the degree of the Equator at the Horizon, and the prick in the Equator, made as in the laſt Probleme, and reduce that number of degrees into minutes of Time, by reckoning 4 minutes of Time for every degree of the Equator. Reduce alſo the number of degrees and minutes that paſs through the Meridian in one Planetary Hour into minutes, by allowing (as aforeſaid) 4 minutes for every degree, and then divide the firſt number by the ſecond, and the Quotient ſhall be the number of Planetary Hours ſince Sun Riſing. Having the number of Planetary Hours ſince Sun Riſing, Reckon the firſt Planetary Hour by the name of that Planet that bears the denomination of the Day, the ſecond Planetary Hour by the Planet ſucceeding that in order, the third by the next in order, and ſo for all the reſt till you come to the laſt Planet, viz. ☾; and then begin again with ☿, and ſo to ♃ &c. till you have reckoned ſo many Planets as there are Planetary Hours ſince Morning: and that Planet the number ends on ſhall be the Planet reigning that Planetary Hour.

Example.

July 27. as aforeſaid, I would know what Planet rules at 5 a clock paſt Noon: The length of the Planetary hour this Day (found by the laſt Probleme) is 1 hour 14 minutes: Therefore the Globe Rectified, I bring the Index of the Hour-Circle to the Hour of the Day, viz. 5 a clock in the Hour-Circle, and then count the number of Degrees between the Prick made, as by the laſt Probleme, and the degree of the Equator at the Horizon; and find them 187. which I reduce into minutes, by allowing for every degree 4 minutes; and that gives 748 minutes. This 748 minutes I divide by the minutes contained in one Planeta-

ry Hour this Day, viz. by 72. and find 10 hours 8 minutes; which ſhews there are 10 Planetary Hours and 8 minutes paſt and gon ſince Sun Riſing. Therefore ♂ being the Planet after whoſe name the Day is called, viz. *Dies Martis*, ♂ is as aforeſaid, the Ruler of the firſt Planetary Hour: From him I count the Planet ſucceeding, which is ☉ for the ſecond hour; from ☉ I count the Planet ſucceeding, which is ♀ for the third hour, and ſo on to ☿ and ☾: and then I begin the Round again with ♄, ♃, ♂, and ☉, till I come again to ♀, which is the tenth Planetary hour ſince Sun Riſing: and the minutes remaining, being 8 ſhews that there is 8 minutes paſt ſince ſhe began to Reign.

PROB. V.

To find Part of Fortune *by the Globe.*

COunt the number of degrees and minutes contained between the Suns place and the Moons place, beginning at the Suns place and counting according to the ſucceſſion of Signes till you come to the Moons place: and having found that number of degrees and minutes add them to the number of degrees and minutes Aſcending, reckoned from the firſt point of ♈: If the ſum exceed 360. caſt away 360, and the remainder ſhall be the number of degrees and minutes from the firſt point in ♈, in which Part of Fortune falls. But if it do not exceed 360. you have already the number of degrees and minutes from the firſt point of ♈ in which you muſt place Part of Fortune.

Example.

I would find the place of Part of Fortune for the time of our Figure: I ſeek the two pricks repreſenting ☉ and ☾, and find ☉ in ♌ 14. 9. and ☾ in ♏ 19.44. therefore counting from the Suns place to the Moons place according to the ſucceſſion of Signes, I find 95. degrees 35. minutes contained between them: This 95. degrees 35. minutes I add to 267. degrees 47. minutes, the degree and minute contained between the firſt point of ♈, and the Aſcendent; and they make together 363 degrees 22 minutes. This exceeds 360. therefore I caſt away 360. and the remains are 3 degrees 22 minutes, for the place in the Ecliptick of Part of Fortune, reckoned from the firſt point of ♈.

Therefore

Therefore this character ⊗ which represents *Part of Fortune*, I set in its proper place of the Figure, as I did the Planets.

PROB. VI.

To find in what Circle *of* Position *any* Star, *or any degree of the* Ecliptick *is*.

CIrcles of Position are numbred from the Horizon upward upon the Quadrant of Altitude placed at the East or West point of the Horizon. Therefore when you would find what Circle of Position any Star or degree of the Ecliptick is in, Rectifie the Globe and Quadrant of Altitude, and bring the lower end of the Quadrant of Altitude to the East or West point of the Horizon, and lift up the Circle of Position till it come to the Star or degree of the Ecliptick proposed: and the number of degrees the Circle of Position then cuts in the Quadrant of Altitude is the number of the Circle of Position that the Star or degree of the Ecliptick is in. If the Star or degree of the Ecliptick be under the Horizon, turn the Globe about till 180. degrees of the Equator pass through the Meridian, then will the Star or degree of the Ecliptick be above the Horizon: Lift up then the Circle of position (as before) to the Star or degree of the Ecliptick, and the number of degrees of the Quadrant of Altitude the Circle of position cuts on the East side, is the number of Circles of Position the Star was under the Horizon on the West side: Or so many degrees as the Circle of Position cuts on the Quadrant of Altitude in the West side the Horizon is the number of the Circles of Position the Star or degree of the Ecliptick was under the Horizon on the East side.

PROB. VII.

To find the Right Ascensions, *the* Oblique Ascensions, *and the* Declinations *of the* Planets.

EXamine the Right Ascensions and Declinations of those pricks made to represent each Planet, in Prob. 1. of this Book; and work by them as you were directed to work by the Sun, in Prob. 26.27 28. of the second Book.

PROB. VIII.

How to Direct *a* Figure *by the* Globe.

TO Direct a Figure is to examine how many degrees of the Equinoctial are moved Eaſtwards or Weſtwards, while any Planet or Star in one Houſe comes to the Cuſp or any other point of any other Houſe.

When you would Direct any Promittor to any Hylegyacal point, examine the degree of the Equator at the Meridian; then turn about the Globe till the Promittor come to the Hylegiacal point, and examine again the degree of the Eqnator at the Meridian: and by ſubſtracting the leſſer from the greater you will have the number of Degrees that paſſed through the Meridian while the place of the Promittor was brought to the Hylegiacal point: and that number of Degrees ſhall be the Arch of Direction.

Example.

I would Direct the Body of the Moon in our Figure aforeſaid to Medium Cœli or the tenth Houſe: I find by the Globe 203 degrees 30 minutes of the Equator at the Meridian with the tenth Houſe, and turning the Globe till the prick made to repreſent the Moon come to the Meridian, I find 227 degrees 20 minutes of the Equator come to the Meridian with it; Therefore I ſubſtract the leſſer from the greater viz. 203 degrees 30 minutes, from 227 degrees 20. minutes, and have remaining 23 degrees 50 minutes.

This 23 degrees 50 minutes ſhews that 23 Years 10 Moneths muſt expire ere the effects promiſed by the Moons preſent poſition ſhall operate upon the ſignification of the tenth Houſe.

If the Body of the Moon had been Directed to any other point than the Meridian or Horizon; you muſt have elevated the Circle of Poſition to the point propoſed; and have under-propped it to that Elevation, and then have turned about the Globe till the prick repreſenting the Moon had come to the Circle of Poſition; and then the degrees of the Equator that ſhould have paſſed through

through the Meridian whiles this motion was making, ſhould be the number of degrees of Direction; and ſinigifie in Time as aforeſaid.

PROB. IX.

Of Revolutions: *and how they are found by the* Globe.

BY a Revolution is meant the Annual converſion of the Sun to the ſame place he was in at the Radix of any Buſineſs. when you would find a Revolution by the Globe, firſt find the Right Aſcenſion of Mid Heaven at the Radix of the Buſineſs, as by Prob. 26 of the ſecond Book you were directed to find the Right Aſcenſion of the Sun; and to it add 87 degrees for every Year ſince the Radix: Then ſubſtract 360 ſo oft as you can from the whole and the Remaines ſhall be the Right Aſcenſion of Mid Heaven for the Annual Revolution.

If you count the number of degrees of the Equator contained between the Right Aſcenſion of the Mid Heaven and the Right Aſcenſion of the Sun, and convert that number of degrees into Time, by allowing for every 15 degrees 1 Hour of Time, it will ſhew, if the Suns place be on the Weſtern ſide of the Meridian the number of Hours and minutes Afternoon the Revolution ſhall happen on, but if on the Eaſt ſide the Meridian, the number of Hours and minutes Beforenoon the Revolution ſhall happen on.

PROB. X.

How a Figure of Heaven *may be erected by the* Revolution *thus found.*

SEek the degree of Right Aſcenſion of Mid Heaven, and bring it to the Meridian, ſo ſhall the four Cardinal points of the Globe be the ſame with the four Cardinal points in Heaven at the time of the Revolution. The other Houſes are found by the Circle of Poſition: as in the firſt Probleme of this Book.

The End of the Fourth Book.

The Fifth BOOK,

Shewing the Practical Uſe of the

GLOBES.

Applying them to the Solution of

Gnomonical Problemes.

PRÆFACE.

DYals *are of two ſorts,* Pendent, *and* Fixed. Pendent *are ſuch as are hung by the hand and turned towards the Sun; that by its Beames darting through ſmal Pin-holes made for that purpoſe, the hour of Day may be found. Theſe are of two ſorts,* Univerſal, *and* Particular.

Univerſal Dyals *are thoſe commonly called* Equinoctial *or Ring-Dyals: They are uſed by Sea-men and Travellers, that often ſhift Latitudes.*

Particular *are ſuch as are made and only ſerve for Particular Latitudes. Of theſe ſorts are the ſeveral Dyals deſcribed on Quadrants, Cilinders, &c.*

Fixed Dyals *ſhall be the matter of this diſcourſe; and they are ſuch as are made upon fixed Planes, and ſhew the Hour of the Day by a* Stile *or* Gnomon *made Parallel to to the Axis of the World.*

Of

Of the ſeveral Kinds of Dyal Plains: and how you may know them.

A Plane in Dyalling is that flat whereon a Dyal is diſcribed.

There is ſome diſagreement among Old and Latter Authors in the naming of Plains: for ſome name them according to the Great Circle in Heaven they ly in, and others according to the ſcituation of the Poles of the Plains. Thus they which name them according to the Great Circle in Heaven their Plains ly in, call that an Horizontal Plain, which others call a Vertical Plain, thoſe Vertical, Plains which others will call Horizontal; and thoſe Polar which others call Equinoctial.

However they be called it matters not, ſo you can but diſtinguiſh their kinds, which with a little conſideration you may eaſily learn to do: For remembring but upon what grounds either the Older or Latter Authors gave the Plains their names, upon the ſame grounds you may alſo learn to know them. I confeſs both waies admit of ſome juſt exception againſt, for in the Older Rule a Plain about the Pole, is called an Equinoctial Plain; when as to a ſudden apprehenſion it would ſound more ſignificant to call it a Polar Plain, as Latter Authors do: Again, Latter Authors call an Horizontal Plain a Vertical Plain; when as it ſounds more ſignificant to call it an Horizontal Plain, as Older Authors do: becauſe it lies flat upon the Horizon: But I ſhall give you the names according to both Rules, and leave you to your liberty to accept of which you pleaſe.

Firſt therefore, you have an Equinoctial Plain, or otherwiſe called a Polar plain. This Plain hath two Faces upper, and under: Theſe two Faces ly in the Plain of the Equinoctial: the upper Face beholding the Elevated Pole, the under Face the depreſſed Pole.

2. An Horizontal Plain, otherwiſe called a Vertical Plain: it lies in the Plain of the Horizon, directly beholding the Zenith.

Erect Plains, otherwiſe called Horizontal Plains, are the ſides of Walls, and theſe are of ſeven ſorts *viz.* 1. Erect Direct Vertical, North or South, 2 Erect Direct, Eaſt or Weſt. 3. Erect Vertical Declining, 4 Erect Inclining Direct. 5. Erect Inclining Declining. 6. Erect Reclining Direct. 7. Erect Reclining Declining.

3 Erect Vertical, North or South Direct, otherwiſe called

Direct North or South Horizontals, behold the North or South Directly, and ly in the Eaſt or Weſt Aizmuth.

4. Erect Direct Eaſt or Weſt, otherwiſe called Direct Eaſt or Weſt Equinoctials, behold the Eaſt or Weſt Directly, and lies in the Plain of the Meridian, having its Poles in the Equinoctial.

5. Erect Vertical Declining Plains, otherwiſe called Declining Horizontals, do not behold the North or South Directly, but ſwerves from them ſo much as the Azimuth Parallel to their Plains ſwerves or Declines from them.

6. Erect Inclining Direct Plains, have the upper ſide of their Plains Inclining or coming towards you, and their Plains do exactly behold either the Eaſt, Weſt, North, or South.

7. Erect Reclining Direct Plains, have the upper ſide of their Plains Reclining or falling from you, and their Plains exactly beholding either the Eaſt, Weſt, North, or South.

8. Erect Reclining Declining, or Erect Inclining Declining Plains, are thoſe Plains which are either Inclining or Reclining, but do not behold the Eaſt, Weſt, North, or South, Directly, but ſwerve or Decline more or leſs from them.

9. Polar Plains are Parallel to the Axis of the World, and to the Meridians that cuts the Eaſt and Weſt, or North and South points of the Horizon.

All theſe kinds of Plains have two Faces; the one beholding the North Pole with the ſame reſpect that the other beholds the South Pole; except the Equinoctial Plain, which becauſe neither Pole is elevated, hath but one Face: yet that one contains as many Hour lines as two other Faces.

Theſe two Faces or Plains will receive juſt 24 hour-lines, for the 24 hour-lines of Day and Night: for ſo much as the one ſide or Face wanteth or exceedeth 12, the other ſide ſhall either exceed or want of 12.

Every Dyal Plain is parallel to the Horizon of ſome Countrey or other of the Earth: therefore a Dyal made for any Horizon of the Earth may be ſet to ſuch a poſition that it will ſhew you the Hour of the Day in your own Habitation: at leaſt for ſo long as the Sun continues upon that Plain.

All Plains may be aptly demonſtrated by the Globe, by ſetting it correſpondent to all the Circles in Heaven, as by Prob. 2. of the ſecond Book: for if you imagine the Globe in that poſition were preſt flat into the Plain of any Circle, that Flat ſhall repre-

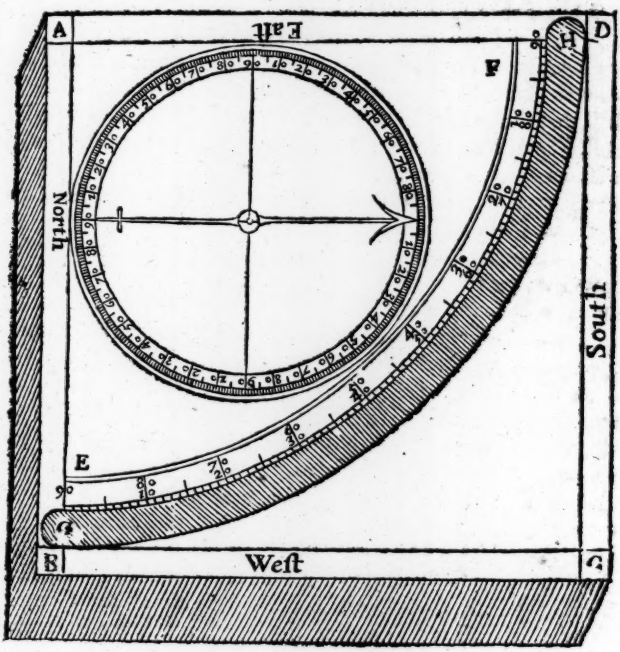
repreſent a Dyal plain, which ſhall be called after the name of that Circle it is preſt into.

Thus if the Quadrant of Altitude be applyed to any degree of Azimuth, and you imagine the Globe were preſt flat to the edge of the Quadrant of Altitude, ſo much as that Azimuth declines from the Eaſt, Weſt, North, or South, in the Horizon, ſo much ſhall that flat on the Globe be ſaid to Decline either from the Eaſt, Weſt, North, or South. Or if you imagine the Globe were preſt flat down even with the Plain of the Horizon, that flat ſhall repreſent an Horizontal Plain; becauſe as was ſaid before, the Plain lies in that Circle cal'd the Horizon.

The Style or Gnomon is that ſtraight wyer that caſts the ſhadow upon the Hour of the Day: it is alwaies placed Parallel to the Axis of the World.

There are ſeveral waies to find the ſcituation of all Plains; but the readieſt and ſpeedieſt is by a Clinatory. The Clinatory is made of a ſquare board, as A B C D, of a good thickneſs, and the larger the better; between two of the ſides is diſcribed on the Center A a Quadrant as E F divided into 90 equal parts or degrees, which are figured with 10, 20, 30, to 90; and then back again with the Complements of the ſame numbers to 90: between the Limb and the two Semi-diameters is made a Round box, into which a Magnetical Needle is fitted; and a Card of the Sea Compaſs, divided into 4 Nineties, beginning their numbers at the Eaſt, Weſt, North, and South points of the Compaſs, from which points the oppoſite ſides of the Clinatory receives their Names of Eaſt, Weſt, North, and South. Upon the Center A whereon the Quadrant was diſcribed is faſtned a Plumb-line, having a Plumbet of Lead or Braſs faſtned to the end of it, which Plumb-line is of ſuch length that the Plumbet may fall juſt into the Grove G H below the Quadrant, which is for that purpoſe made of ſuch a depth that the Plumbet may ride freely within it, without ſtopping at the ſides of it. See the Figure annexed.

With this Clinatory you may examine the ſcituation of Plains. As if your Plain be Horizontal; it is Direct: and then for the true ſcituating your Dyal you have only the true North and South line to find: which is done only by ſetting the Clinatory flat down upon the Plain, and turning it towards the right or left hand, till you can bring the North point of the Needle to hang



juſt over the Flower-de-luce; for then if you draw a line by either of the ſides Parallel to the Needle, that line ſhall be a North and South line. But herein reſpect muſt be had to the Variation of the Compaſs in the Place you make your Dyal: for if the North point of the Needle ſwerves from the North point of the World, then have you not a true North and South line. But if in your Place there be no Variation of the North point of the Needle from the North point of the World (as now it happens here at *London*) then the line drawn by the ſide of the Clinatory (as aforeſaid) ſhall be a true North and South line.

But admit there be Variation. Having by Prob. 19. of the third Book found the number of degrees of this Variation towards the Eaſt or Weſt, count the ſame number of degrees from the

the North point in the Card either to the Eaſtwards or Weſtwards, and note the degree in the Card terminating at that number, for that degree ſhall be the North point; and its oppoſite degree the South point: 90. degrees from it either way ſhall be the Eaſt and Weſt points.

Therefore, whereas before you were directed to turn the Clinatory till the North point of the Needle point to the Flower-de-luce on the Card, you muſt now turn (or move) the Clinatory till the North point of the Needle hang juſt over the degree of Variation thus found; and then a line drawn as aforeſaid, by the ſide of the Clinatory Parallel to the Needle ſhall be a North and South line, or (to ſpeak more properly) a Meridional line.

You may find a Meridian line ſeveral other waies; as firſt; If the Sun ſhine juſt at Noon, hold up a Plumb-line ſo as the ſhadow of it may fall upon your Plain; and that ſhadow ſhall be a Meridian line.

Secondly, on the backſide the Clinatory diſcribe a Circle, and draw a line through the Center to both ſides the Circumference; croſs this line with an other line at Right Angles in the Center, ſo ſhall the Circle be divided into four equal parts. Theſe four parts you muſt mark with Eaſt, Weſt, North, South; and divide each of them into 90. degrees. In the Center of this Plain erect a ſtraight wyer perpendicularly: when you would find a Meridian line examine by the tenth Prob. of the ſecond Book, the Amplitude of the Suns Riſing or Setting from the Eaſt or Weſt points, and waiting the juſt Riſing or Setting that Day, turn the Inſtrument about till the ſhadow of the wyer falls upon the ſame degree from the Eaſt or Weſt the Amplitude is of, for then the North and South line in the Inſtrument will be the ſame with the North and South line in Heaven.

Thirdly by the Suns Azimuth: Find the Azimuth of the Sun by Prob. 22. of the ſecond Book: and at the ſame inſtant turn the Inſtrument till the ſhadow of the wyer fall upon the degree on the Inſtrument oppoſite to the degree of the Suns Azimuth, ſo ſhall the Meridional line of the Inſtrument agree with the Meridional line in Heaven.

You may the ſame way work by the Azimuth of any Star: Only, whereas the ſhadow of the wyer ſhould fall upon the oppoſite degree aforeſaid: Now you muſt place a Sight or Perpendicular upon that oppoſite degree, and turn the Inſtrument a-

bout till the wyer at the Center, the Sight in the oppoſite degree of the Stars Azimuth, and the Star in Heaven, come into one ſtraight line, ſo ſhall the Meridian line of the Inſtrument agree with the Meridional line in Heaven.

Fourthly, It may be found by any Star obſerved in the Meridian, if two perpendiculars be erected in the Meridian line of your Inſtrument; for then by turning the Inſtrument till the two Perpendiculars and the Star come into a ſtraight line, the Meridian line of your Inſtrument will be the ſame with the Meridian line in Heaven. See more waies in Mr *Palmer* on the *Planiſphear*, Book 4. Chap. 7.

If your Plain either Recline or Incline, apply one of the ſides of your Clinatory Parallel to one of the Semi-diameters of the Quadrant to the Plain, in ſuch ſort that the Plumb-line hanging at liberty may fall upon the Circumference of the Quadratn, for then the number of degrees of the Quadrant comprehended between the ſide of the Quadrant Parallel to the Plain, and the Plumb-line ſhall be the number of degrees of Reclination, if the Center of the Quadrant points upwards; or Inclination, if the Center points downwards.

If your Reclining or Inclining Plain Decline, draw upon it a line Parallel to the Horizon, which you may do by applying the back-ſide of the Clinatory, and raiſing or depreſſing the Center of the Quadrant till the Plumb-line hang juſt upon one of the Semi-diameters, for then you may by the upper ſide of the Clinatory draw an Horizontal line if the Plain Incline, or by the under ſide if it Recline. If it neither Incline nor Recline, you may draw an Horizontal line both by the upper and under ſides of the Clinatory. Having drawn the Horizontal line, apply the North ſide of the Clinatory to it, and if the North end of the Needle points directly towards the Plain, it is then a South Plain. If the North point of the Needle points directly from the plain, it is a North plain: but if it points towards the Eaſt, it is an Eaſt plain: if towards the Weſt a Weſt Plain. If it do not point directly either Eaſt, Weſt, North, or South, then ſo many degrees as the Needle declines from any of theſe four points to any of the other of theſe four points, ſo many degrees is the Declination of the Plain, with reſpect (as aforeſaid, had to the Variation of the Compaſs.

Or if you find the Azimuth of the Sun by its Altitude obſerved juſt when its beames are coming on or going off your Plain

Plain, that Azimuth ſhall be the Azimuth of your Plain.

Or you may erect a wyer Perpendicularly on your Plain, and wait till the ſhadow of that wyer comes to the Perpendicular with the Horizon, which you may examine by applying a Plumb-line to it, for then the ſhadow of the Plumb-line and the ſhadow of the Perpendicular will be in one: then taking the Altitude of the Sun you may by Prob. 22. of the ſecond Book find its Azimuth, and thereby know in what Azimuth the Plain of your Dyal lies: for the Azimuth your Plain lies in is diſtant from the Azimuth of the Sun juſt 90. degrees.

PROB. I.

How by one poſition of the Globe *to find the diſtances of the* Hour-lines *on all manner of Plains.*

YOu may have Meridian lines drawn from Pole to Pole through every 15. deg. of the Equinoctial, to repreſent the Horary motion of the Sun both Day and Night; and when the Pole of the Globe is Elevated to the height of the Pole in any Place and one of theſe Meridian lines be brought to the Brazen Meridian, all the reſt of the Meridian lines ſhall cut any Circle which you intend ſhall repreſent the Plain of a Dyal in the number of deg. on the ſame Circle that each reſpective Hour-line is diſtant from the Noon-line point in the ſame Circle.

Thus if you ſhould enquire the diſtance of the Hour-lines upon an Horizontal Plain in *Londons* Latitude; The Pole of the Globe (as aforeſaid) muſt be Elevated 51½ degrees, and one of the Meridian lines (you may chuſe the Vernal Colure) be brought to the Brazen Meridian, which being done, you are only to examine in the Horizon (Becauſe it is an Horizontal Plain) at what diſtance from the Meridian (which in Horizontals is the Noon-line) the ſeveral Meridians drawn on the Globe interſect the Horizon, for that diſtance in degrees ſhall be the diſtance on a Circle divided into 360. degrees that each reſpective Hour-line muſt have from the Meridian, or a Noon-line choſen in the ſame Circle; and lines drawn from the Center of that Circle through thoſe degrees ſhall be the Hour-lines of an Horizontal Plain.

If it be an Erect Direct South Dyal you enquire after; Keeping

ing the Globe in its former poſition, apply the Quadrant of Altitude to the Zenith, and its lower end to the Eaſt point of the Horizon, for then (as was ſhewed in the *Preface*) by imagining the Globe to be preſt flat to the graduated edge of the Quadrant of Altitude, that flat ſhall be a South Plain, and the number of degrees the Meridians cuts in the Quadrant of Altitude numbred from the Zenith downwards ſhall be the number of degrees that each Hour line ſhall be diſtant from the Meridian or Noon-line in a Circle of 360. degrees, and lines drawn from the Center of that Circle through thoſe degrees, ſhall be the Hour lines of half the Day: the Hour lines for the other half of the Day are of the ſame diſtance from the Noon-line, with theſe; only they muſt be placed on the other ſide the Noon-line.

If your Plain be not Direct but declines Eaſt or Weſt, you muſt number the Declination Eaſtwards or Weſtwards reſpectively in the degrees of the Horizon and (the Quadrant of Altitude

Altitude ſcrewed to the Zenith, (as aforeſaid) bring the lower end of the Quadrant of Altitude to the ſaid degrees of Declination, and the number of degrees cut by the Meridians in the Quadrant of Altitude (numbred downwards, is the number of degrees that the Hour-lines are diſtant from the Noon line in a Circle of 360. degrees: And lines drawn from the Center of that Circle through thoſe degrees be the Hour lines of half the Day. And if you turn about the Quadrant of Altitude upon the Zenith point till the lower end of it come to the degree of the Horizon oppoſite to the degree of Declination found before, the Meridian lines on the Globe (as before) ſhall cut the Quadrant of Altitude in the number of degrees (counted downward) that each Hour-line is diſtant from the other ſide the Noon-line: And lines drawn from the Center of that Circle through thoſe degrees ſhall be the Hour-lines of the other half of the Day.

If your Plain Decline and alſo Recline or Incline, you muſt uſe the Gnomonical Semi-Circle, diſcribed in Prob. 12. which muſt be Elevated on the Quadrant of Altitude when it is ſet to the Declination (as by the former Rule) according to the complement of Reclination, or Inclination. But if your Plain be Direct, and Recline, or Incline, it muſt be ſet to the Meridian, and the Meridians on the Globe ſhall cut that Semi-Circle in the number of degrees counted from the Quadrant of Altitude, if the Plain Declines, or from the Braſen Meridian, if it be Direct, that the ſeveral Hour-lines are diſtant from a line Perpendicular to an Horizontal line in a Circle divided into 360 degrees: And lines drawn from the Center through thoſe degrees ſhall be the Hour-lines of ſuch Reclining or Inclining Plains.

If your Plain be an Eaſt or Weſt, either Direct or Declining; or an Equinoctial Plain (for they are upon the matter all one) you may better conceive how they are to be made, than make them by the Globe. And for the help of your fancy herein, take Mr *Blagraves* conceit, who in his Book 6. Chap. 8. very properly demonſtrates the Rules for projecting the Hour-lines on theſe Plains. He propoſes to take 12. wyers bowed into exact Circles, all of equal Diameter, and ſet together at equal diſtance one from another in two oppoſite points, as in two Poles, and to have a ſtraight line to paſs from one Pole to another, as an Axis, Theſe 12. wyers ſhall repreſent 24. Meridional Semi-Circles; Or indeed they may repreſent the Globe it ſelf, containing 24. Me-

ing the Globe in its former poſition, apply the Quadrant of Altitude to the Zenith, and its lower end to the Eaſt point of the Horizon, for then (as was ſhewed in the *Preface*) by imagining the Globe to be preſt flat to the graduated edge of the Quadrant of Altitude, that flat ſhall be a South Plain, and the number of degrees the Meridians cuts in the Quadrant of Altitude numbred from the Zenith downwards ſhall be the number of degrees that each Hour line ſhall be diſtant from the Meridian or Noon-line in a Circle of 360. degrees, and lines drawn from the Center of that Circle through thoſe degrees, ſhall be the Hour lines of half the Day: the Hour lines for the other half of the Day are of the ſame diſtance from the Noon-line, with theſe; only they muſt be placed on the other ſide the Noon-line.

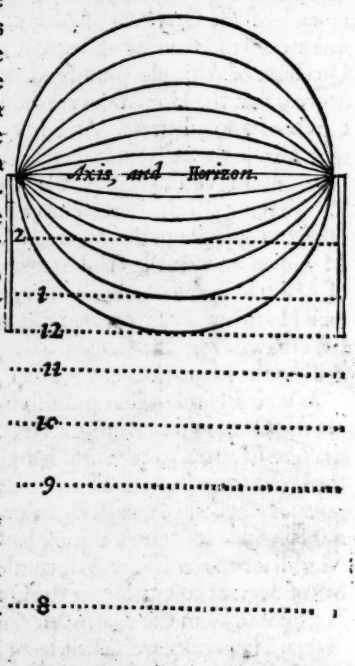
If your Plain be not Direct but declines Eaſt or Weſt, you muſt number the Declination Eaſtwards or Weſtwards reſpectively in the degrees of the Horizon and (the Quadrant of Altitude

Altitude ſcrewed to the Zenith, (as aforeſaid) bring the lower end of the Quadrant of Altitude to the ſaid degrees of Declination, and the number of degrees cut by the Meridians in the Quadrant of Altitude (numbred downwards, is the number of degrees that the Hour-lines are diſtant from the Noon line in a Circle of 360. degrees: And lines drawn from the Center of that Circle through thoſe degrees be the Hour lines of half the Day. And if you turn about the Quadrant of Altitude upon the Zenith point till the lower end of it come to the degree of the Horizon oppoſite to the degree of Declination found before, the Meridian lines on the Globe (as before) ſhall cut the Quadrant of Altitude in the number of degrees (counted downward) that each Hour-line is diſtant from the other ſide the Noon-line: And lines drawn from the Center of that Circle through thoſe degrees ſhall be the Hour-lines of the other half of the Day.

If your Plain Decline and alſo Recline or Incline, you muſt uſe the Gnomonical Semi-Circle, diſcribed in Prob. 12. which muſt be Elevated on the Quadrant of Altitude when it is ſet to the Declination (as by the former Rule) according to the complement of Reclination, or Inclination. But if your Plain be Direct, and Recline, or Incline, it muſt be ſet to the Meridian, and the Meridians on the Globe ſhall cut that Semi-Circle in the number of degrees counted from the Quadrant of Altitude, if the Plain Declines, or from the Braſen Meridian, if it be Direct, that the ſeveral Hour-lines are diſtant from a line Perpendicular to an Horizontal line in a Circle divided into 360 degrees: And lines drawn from the Center through thoſe degrees ſhall be the Hour-lines of ſuch Reclining or Inclining Plains.

If your Plain be an Eaſt or Weſt, either Direct or Declining; or an Equinoctial Plain (for they are upon the matter all one) you may better conceive how they are to be made, than make them by the Globe. And for the help of your fancy herein, take Mr *Blagraves* conceit, who in his Book 6. Chap. 8. very properly demonſtrates the Rules for projecting the Hour-lines on theſe Plains. He propoſes to take 12. wyers bowed into exact Circles, all of equal Diameter, and ſet together at equal diſtance one from another in two oppoſite points, as in two Poles, and to have a ſtraight line to paſs from one Pole to another, as an Axis, Theſe 12. wyers ſhall repreſent 24. Meridional Semi-Circles; Or indeed they may repreſent the Globe it ſelf, containing 24. Me-

ridional Semi-Circles to be diſcribed on the Globe, as aforeſaid; And if you place the Horizon of the Globe Horizontal, and the North and South points of the Globe towards the North and South points in Heaven, and bring one of theſe Wyer Meridians directly under the Brazen Meridian, and the Axis of this Wyer-Globe in the Plain of the Horizon, and faſten a Thred in the middle of the Axis, that thred drawn from the middle of the Axis by every one of theſe wyers ſhall, if prolonged till it touch an Eaſt and Weſt line drawn directly under or over the points Zenith or Nadir, point out on that Eaſt and Weſt line the diſtances of each Hour-line from the 12 a clock line; and lines drawn at Right angles through that Eaſt and Weſt line, ſhall be the Hour-lines of an Eaſt or Weſt Plain, or of an Equinoctial Plain.



The moving this thred from wyer to wyer repreſents the motion of the Sun, which as it paſſes over all the Meridians cauſes the ſhadow of that Meridional Semi-circle which it is directly over, and the Axis, and the Meridional Semi-circle directly oppoſite to the upper Meridional Semi-circle to fall all into one ſtraight line: and upon what point in the Eaſt and Weſt line (mentioned before) that ſhadow-line ſhall fall is marked out by the application of the thred as aforeſaid: and is an Hour-line on any of the foreſaid Plains.

If you underſtand this Probleme rightly, you already know how to draw the Hour-lines upon all manner of Plains, and need no further Inſtructions; yet partly fearing a young Student ſhould

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not clearly understand these Rules, and partly doubting (because other Authors have been more Copious upon this Subject) that I should be censured to be too sparing of my pains, if I should lightly touch so eminent a Doctrine as Dyalling is: Therefore I shall more distinctly handle Dyalling by the Globe, according to the way or Method that other Authors have used, and that after so plain a manner as possible my Genius can devise.

PROB. II.

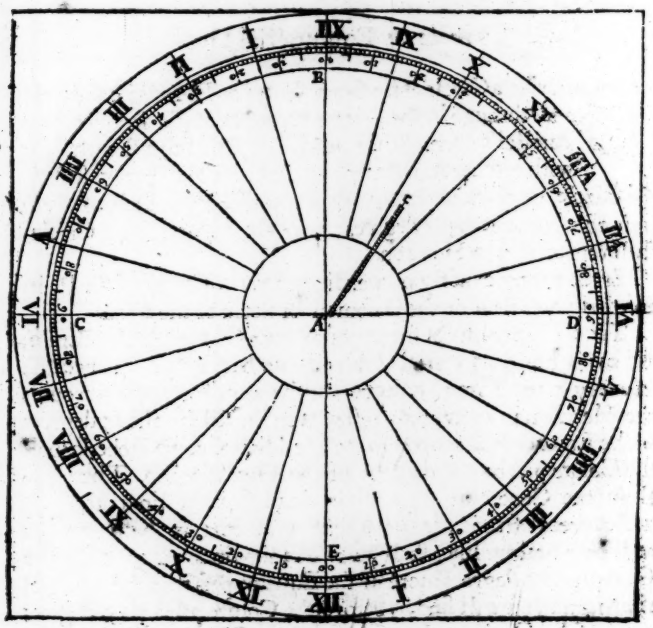
To make an Equinoctial Dyal.

Describe a Circle, on a square Board or Plain, as B C E D and through A the Center thereof draw a straight line Parallel to one of the sides, as B E; Cross that straight line with another straight line as C D at Right Angles: so shall the Circle be divided into 4 equal parts. Divide each of these four equal parts into 90. degrees; as in the Figure. This Circle, shall represent the Horizon.

Erect a wyer exactly perpendicular to the Center of the Plain and that wyer shall be the Gnomon or Style of the Dyal.

Then Elevate one of the Poles of your Globe into the Zenith, and bring the Equinoctial Colure to the Meridian. And because in every hours Time 15. degrees of the Equator passes through the Meridian in Heaven, therefore turn the Globe till 15 degrees of the Equator passes through the Meridian of your Globe; so shall the Colure pass by 15. degrees of the Horizon also. Therefore from the Center of your Plain draw straight lines through 15. degrees from one of the Semidiameters both waies: and those straight lines shall be two Hour-lines. Then turn the Globe till 15. degrees more of the Equator pass through the Meridian, and you will find, as before, the Colure pass by 15. degrees more of the Horizon: therefore on your Plain number 15. degrees further beyond both the former lines, and from the Center draw straight lines through both those 15. degrees, and they shall be two Hour lines more. For all the other Hour lines turn the Globe till 15. degrees of the Equator at a time pass through the Meridian, as before, and you will find that for every 15. degrees of the Equator that passes through the Meridian, the Colure will pass through 15. degrees of the Horizon: therefore those

Hour lines muſt be drawn from the Center according to the ſucceſſion of every 15. degrees on your Plain. Having drawn the Hour lines, you may ſet figures on them, beginning to number your Hour lines from one of the Diameters, marking it with XII, and the next Hour line to the left hand with I, and the next II, the next III, &c. to XII and begin again with I, II, III, &c. till you come to the other XII, where you began: and then your Dyal is finiſhed. See the Figure.



This is an Univerſal, Dyal and ſerves in all Latitudes: therefore when you place it you muſt ſet one of the XIIs downwards, and the Axis Parallel to the Axis of the world.

But note, Both faces of this Dyal ought to be divided, and the Gnomon muſt appear no both ſides like the ſtick in a whirligig, which children uſe; or elſe you muſt turn it upſide down, ſo oft as the Sun paſſes the Equinoctial.

PROB.

PROB. III.

To make an Horizontal Dyal.

Describe a Circle on your Plain, as C B D E, and through the Center A of that Circle draw a Meridian (or twelve a clock line) as B E; croſs that line at Right angles with another line as C D; ſo ſhall your Circle be divided into four equal parts: Divide each of theſe four parts into 90. degrees; ſo ſhall the whole be divided into 360. Theſe 360 degrees repreſent the 360 degrees of the Horizon, which a Meridian line drawn through the place of the Sun runs through in every 24 Hours: The motion of which Meridian line through the degrees of the Horizon is Regular in a Parallel Sphear; for in equal Time it moves an equal Space throughout the whole Circle, viz. it will paſs through 15. degrees of the Horizon in one Hours time, (or which is all one) whiles 15 degrees of the Equator paſſes through the Meridian; as was ſhewed in the laſt Probleme: But in an Oblique Sphear its motion through the Horizon is Irregular, and that more or leſs according to the more or leſs Obliquity of the Sphear: for far Northwards or Southwards you may ſee this Meridian line paſs through 40, 50, yea 60. degrees of the Horizon in one Hours time viz. whiles 15. degrees of the Equator paſſes through the Meridian: but in an other Hours time you will ſcarce have 4. or 5. degrees paſs through the Horizon whiles 15. degrees of the Equator paſſes through the Meridian.

But that you may know the motion of the Sun (repreſented by this Meridian line) through the Horizon in all Latitudes; Elevate the Pole to the Elevation of your Place, and chuſe inſtead of a Meridian line drawn through the Place of the Sun the Vernal Colure to be your Meridian line; both becauſe it is moſt viſible, and becauſe from thence the degrees of the Equator are begun to be numbred, ſo that whatſoever decimal degree of the Equator you light on at the Meridian, or elſe where you will find its number from that Colure already ſet down to your hand, without either adding to or ſubſtracting from it. Bring this Colure therefore to the Meridian, and the Index of the Hour Circle to 12. in the Hour Circle. Then turn the Globe

Weſtwards, and ſo oft as 15 degrees of the Equator paſſes through the Meridian, ſo oft you muſt examine what degree of the Horizon the Vernal Colure cuts; and thoſe degrees and minutes ſo cut by the Vernal Colure muſt be found in the Circle C B D E, beginning your account or reckoning at B towards D, and marckt with pricks: through which pricks you muſt draw lines from the Center A, and thoſe lines ſhall be the Hour lines after noon. Then bring the Colure to the Meridian again to find the fore noon Hour lines, and turn the Globe Eaſtwards, and ſo oft as 15 degrees of the Equator paſſes through the Meridian, ſo oft you muſt examine what degrees of the Horizon the Vernal Coloure cuts; and thoſe degrees and minutes ſo cut by the Vernal Colure muſt be found in the Circle C B D E, beginning your reckoning from B towards C, and markt with pricks: through which pricks you muſt draw lines from the Center A, and thoſe lines ſhall be the fore noon hour lines.

Theſe hour lines muſt be markt from the Meridian line, viz. the line A B, which is the 12 a clock line towards D, with I, II, III, &c. till you have numbred to the Hour of Sun ſet (found by Prob. 7. of the ſecond Book) the longeſt Day, and from the Meridian line towards C with XI, X, IX, &c. till you have numbred to Sun riſing the longeſt Day.

The Style muſt be placed in the Center, and elevated ſo many degrees above the Plain, as the Pole is elevated above the Horizon of the Place.

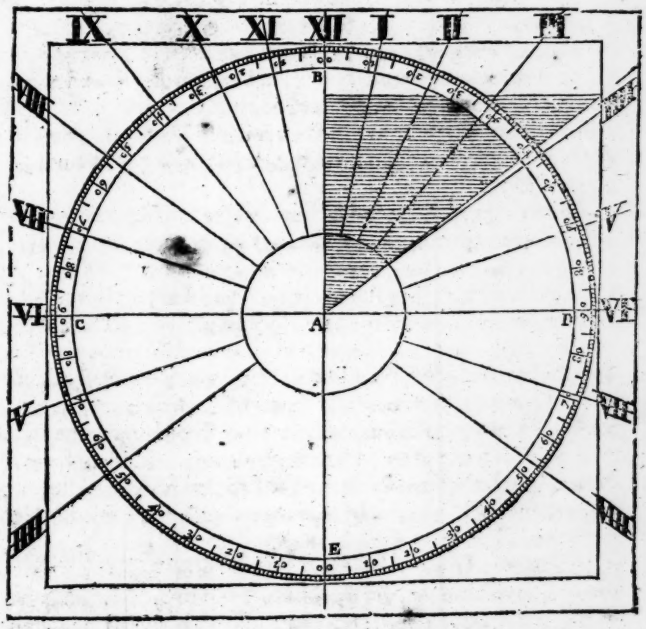
Example of the whole.

I would make an Horizontal Dyal for *Londons* Latitude: Therefore I elevate the North Pole 51 ½ degrees above the Horizon, and bring the Vernal Colure to the Meridian, and the Index of the Hour-circle to 12 on the Hour-circle;

And turning	1	a clock: or till 15	11. 40	
the Globe	2	deg. of the Equa-	24. 15	
Weſtwards,	3	tor paſs through	38. 4	from the Meridian.
till the In-	4	the Meridian; I	53. 36	
dex points	5	find the Colure	71. 6	
to	6	cut the Horiz. in	90.	

Theſe are the diſtances of the Hour lines from Noon till 6 at Night: and to theſe diſtances on the Plain (couning from B towards

wards D,) I make pricks; and from the Center I draw lines through theſe pricks; and theſe lines are the hour-lines from 12 to 6 Afternoon. But the Sun in the longeſt Day ſhines till paſt 8 at Night, as you may find by Prob. 48. of the ſecond Book; therefore here wants the two Evening hour-lines; which though they may be found after the ſame way I found the former, (viz. by continuing the turning the Globe Weſtwards) yet that I may the ſooner [illegible] my work to the Plain, I count the number of degrees between the 7 a clock line and the 5 a clock line in the circle on the Plain; for the ſame number of degrees counted from D towards E is the diſtance of the 7 a clock hour-line from the 6 a clock hour-line; and the number of degrees contained between the 6 a clock hour-line end the 4 a clock hour-line is the diſtance of the 8 a clock hour-line from the 6 a clock hour-line.



Or I need not draw the 7 and 8 a clock hour-lines, till I have drawn the fore noon hour-lines: for then by laying the edge of a Ruler

Ruler (that will reach through the oppoſite ſide of the Plane) to the Morning 7 and 8 a clock hour lines, I may by the ſide of that Ruler draw lines from the Center through the oppoſite ſide of the Plain, and thoſe lines ſhall be the 7 and 8 a clock Hour lines Afternoon.

Having thus all the Afternoon Hour lines, I bring the Vernal Colure to the Meridian again; ſo ſhall the Index again point to 12. Therefore as before I turned the Glo[illegible] Weſtwards, ſo now

turning it Eaſtwards, till the Index points to	11 a clock, or till 15 deg. of the Equator paſs through the Meridian, I find the Colure cut the Horiz. in	11. 40	from the Meridian.
	10	24. 15	
	9	38. 4	
	8	53. 36	
	7	71. 6	
	6	90.	

Theſe are the diſtances of the Hour lines from Noon to 6 a clock in the Morning; and theſe diſtances I ſeek in the Circle of the Plain (counting from the Noon line B towards C) and mark them with pricks; through which pricks (as before) I draw lines from the Center to the outſide the Plain: and thoſe lines ſhall be the Hour lines.

Or, having the diſtance of all the Afternoon Hour lines, I have alſo the diſtance of all the forenoon Hour lines from the Meridian; as you may ſee by comparing the two former Tables: For the 1 a clock Hour line Afternoon is equidiſtant from the Meridian or Noon line with the 11 a clock Hour line before Noon, viz. they are both 11 degrees 40 minutes diſtant from the Noon line, and the 2 a clock hour line after noon is from the Noon line equidiſtant with the 10 a clock hour-line before noon; for they are both 24 deg. 15 minutes diſtant from the Meridian or Noon line: and ſo all the other Morning Hour lines are diſtant from the Noon line by the ſame ſpace that the ſame number of After noon Hour lines (told from the Meridian on the contrary ſide the Noon line) are diſtant from the Meridian.

Whence it follows, that ſince (as aforeſaid) the ſame number of Hour lines after 6 at Night, and before 6 in the Morning have the ſame diſtance from the 6 a clock line that the ſame number of Hour lines before 6 at Night and after 6 in the Morning have from the 6 a clock line; and ſince the ſame number of Hour lines

lines before noon are equidiſtant from the Meridian or Noon line by the ſame ſpace of degrees that the ſame number of Hour lines Afternoon are; It follows (I ſay) that having found the diſtance of the ſix Hour lines either before or after Noon, you have alſo given the diſtance of all the other Hour lines.

If you will have the half Hour lines placed on your Dyal, you muſt turn the Globe till the Index points to every half Hour in the Hour Circle, as well as to the whole, and examine the degrees of the Horzion cut by the Vernal Colure, as you did for the whole Hours; and in like manner transfer them to your Plain.

Having thus drawn all the Hour lines I count from the Noon-line $51\frac{1}{2}$ degrees, the Elevation of the Pole here at *London*; and from the Center A I draw a ſtraight line, as A F through theſe $51\frac{1}{2}$ degrees for the Gnomon or Style, and prolong it to the farthelt extent of the Plain: From this Gnomon or Style I let fall a Perpendicular upon the Noon line as F G: (this Perpendicular is called the Subſtile) and this Perpendicular and its Baſe (which is the Noon line) and Hypothenuſa (which is the Gnomon(ſhall make a Triangle, which being erected upon the Baſe, ſo as the Subſtile may ſtand Perpendicular to the Plain, the Hypothenuſa A F ſhall be the Gnomon, and be Parallel to the Axis of the world; and caſt a ſhadow upon the Hour of the Day.

PROB. IIII.

To make an Erect Direct South Dyal.

DRaw on your Plain an Horizontal line as C A D, as was ſhewed in the Preface: in the middle of this line (as at A) diſcribe as on a Center the Semi Circle C B D: from the Center A let fall a Perpendicular, which ſhall divide the Semi Circle into two Quadrants each of which Quadrants you muſt divide into 90 degrees. Then Rectifie the Globe, Quadrant of Altitude, Colure and Hour Index: thus, Elevate the Pole of the Globe to the Latitude of your Place, and ſcrew the Quadrant of Altitude to the Zenith, Then bring the Vernal Colure to the Meridian, and the Index of the Hour Circle to the Hour of 12 in the Hour Circle; ſo ſhall your Globe, Quadrant of Altitude, Colure, and Hour Index be Rectified. And thus you muſt alwaies Rectifie them for the making of moſt ſorts of Dyals by the

Globe. Then to make an Erect Direct South Dyal, Bring the lower end of the Quadrant of Altitude to the Weſt point of the Horizon; And turn the Globe Weſtwards till the Index points to all the Hours Afternoon; and examine in what numbers of degrees from the Zenith the Colure cuts the Quadrant of Altitude when the Index points to each Hour: for a line drawn from the Center A through the ſame number of degrees reckoned from the Perpendicular A B (which is the 12 a clock line) towards D on the Plain, ſhall be the ſame Hour lines the Index points at.

Thus in our Latitude, viz. 51 ½ degrees the Vernal Colure being brought to the Meridian and the Index to 12,

If you turn the Globe Weſtwards, till the Index points to				counted from the Zenith.
	1	a clock, or till 15 deg. of the Equator paſs through the Meridian, the Colure will cut the Quad. of Alt. in	9. 18	
	2		19. 15	
	3		32. 5	
	4		48. 0	
	5		67. 4	
	6		90.	

And theſe are the diſtances of the after noon Hour lines; which you muſt transfer to the Eaſt ſide of your Plain, viz. from B towards D; and draw lines from the Center A through theſe diſtances; and theſe lines ſhall be your After noon Hour lines.

Note (once for all) when the Colure goes off that Circle you examine the Hour diſtances in, the Sun will ſhine no longer upon that Plain; As in this example, the Colure goes off the Quadrant of Altitude at 6 a clock, therefore the Sun will not ſhine longer then till 6 a clock upon this Plain.

The Hour lines before Noon have the ſame diſtance from the Meridian that the After noon Hour lines have, as was ſhewed in the laſt Probleme: Only they muſt be counted from B towards C, and drawn on the Weſt ſide the Noon line.

Otherwiſe.

You may reduce all Verticals into Horizontals; if you elevate the Pole of the Globe to the Complement of the Latitude of your Place, and bring the Vernal Colure to the Meridian under the Horizon, and the Index of the Hour Circle to 12; and turn the

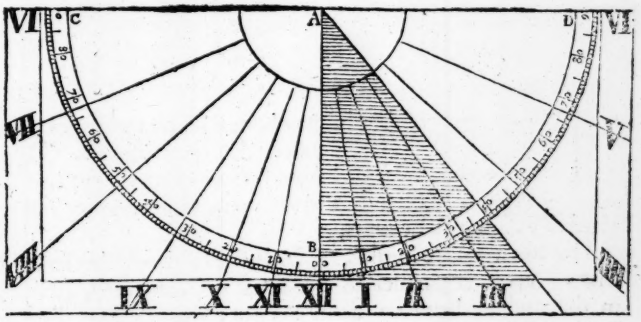
the Globe Weſtwards, for as the Index paſſes through every Hour on the Hour Circle, the Colure ſhews in the Horizon the diſtance of the ſeveral Afternoon Hour lines from the Meridian or 12 a clock line, in the Circle on your Plain, numbred from B to D: and lines drawn from the Center through theſe diſtances on your Plain ſhall be the After noon Hour lines of your Dyal.

Example.

Londons Latitude is 51½ degrees, Its Complement to 90. is 38½. Therefore I elevate the Pole 38½ degrees above the Horizon, and bring the Vernal Colure to the Meridian under the Horizon, and the Index of the Hour circle to 12 on the Hour circle. Then

Turning the Globe Weſtwards, till the Index points to	1	a clock: or till 15 deg. of the Equator paſs through the Meridian; I find the Colure cut the Horiz. in	9. 18	from the interſection of the Meridian and the Horizon as in the former Table.
	2		19. 15	
	3		32. 5	
	4		48. 0	
	5		67. 0	
	6		90.	

And theſe are the diſtances of the 6 Hour lines from the Meridian; As you may ſee in this Figure.



By this Example you may ſee it is eaſie to reduce Verticals into Horizontals: and Horizontals into Verticals: for this Erect Direct South Dyal is an Horizontal Dyal to thoſe People that Inhabite 90 deg. from us, viz in the South Latitude of 38½ degrees.

Then make a Triangle, whereof the Noon line ſhall be

Baſe: from it count the complement of the Poles Elevation, viz. 38½ degrees, and through them draw the line A F, from the center A which ſhall be the Hypotenuſa; Then let fall a Perpendicular upon the Noon line A B, ſo is your Triangle made. If this Triangle be erected perpendicularly upon the Baſe or Noon line, the Hypothenuſa A F ſhall ſtand parallel to the Axis of the World, and caſt a ſhadow upon the Hour of the Day.

PROB. V.

To make an Erect Direct North Dyal.

IF the Erect Direct South Dyal were turned towards the North, and the line C A D were turned downwards, and the line marked with 7 be now marked with 5, and the line 8 with 4, and the line 5 with 7, and the line 4 with 8, then have you of it a North Erect Direct Dyal.

All the other Hour lines in this Dyal are uſeleſs, becauſe the Sun in our Latitude ſhines on a North Face the longeſt Day only before 6 in the Morning, and after 6 at Night.

PROB. VI.

To make an Erect Direct Eaſt Dyal.

THeſe ſorts of Dyals may better be demonſtrated than made by the Globe; unleſs the Axis of your Globe were acceſſible, as in the Wyer-Globe, ſpecified in Prob. 1. Therefore when you would make an Eaſt or Weſt Dyal, or a Polar Dyal,

Provide a ſquare board, as A B C D, draw the ſtraight line *e f* upon it parallel to the ſides A C, and B D, and juſt in the middle between them: Croſs this ſtraight line at Right Angles with another ſtraight line, as *g h*, quite through the Board.

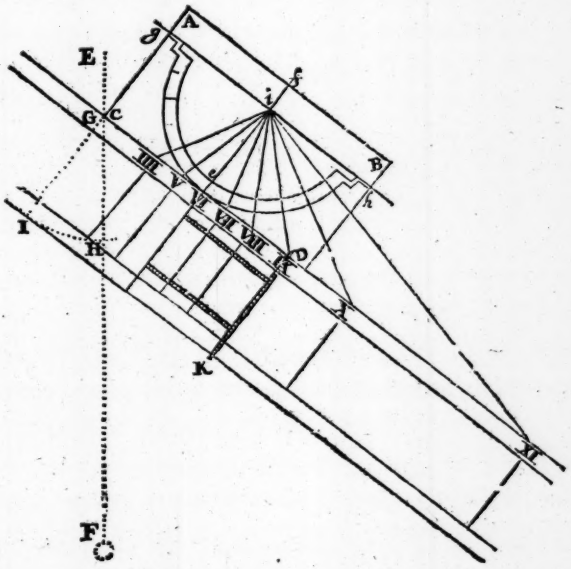
Upon this Board with a little Pitch or Wax faſten the Semi-Circle of Poſition, ſo as both the Poles thereof may ly in the line *g h*, and the middle of the Semi-Circle marked ∞ may ly upon the line *e f*, ſo ſhall *i* be the Center of the Semi-circle of Poſition,

In

In this Center make a ſmal hole through the Board fit to receive a Wyer or a Nail: So may you with the Circle of Poſition thus fitted, and the ſide C D applyed to a line of Contingence elevated to the heigth of the Equinoctial, draw lines from the Center through every 15 degrees of the Circle of Poſition, and by continuing them interſect the line of Contingence in the points from whence the Hour lines of an Eaſt or Weſt Dyal is to be drawn.

Example.

I would make an Erect Direct Eaſt Dyal for *Londons* Latitude. Therefore I faſten a Plumb-line a little above the place



on the wall where I intend to make my Dyal, and wait till it hangs quietly before the Wall: then if the line be rubbed with Chalk (like a Carpenters line) I may by holding the Plumbet end cloſe to the Wall, and ſtraining it pretty ſtif, ſtrike with it a

ſtraight line as Carpenters do. This line ſhall be a Perpendicular as E F: I chuſe a convenient point in this Perpendicular, as at G, for a Center: whereon I diſcribe an occult Arch as H I: this Arch muſt contain the number of degrees of the Elevation of the Equinoctial counted between H and I, (which in our Latitude is 38 ½,) Therefore in a Quadrant of the ſame Radius with the occult Arch I meaſure 38 ½ degrees, and ſet them off in the Plain from H in the Perpendicular to I: Then from I to the Center G in the Perpendicular, I draw the prickt line I G, and this line ſhall repreſent the Axis of the World: I croſs this Axis at Right Angles with the line G K, and draw it from G to K, ſo long as I poſſibly can: this line ſhall be the Contingent-line. I find a convenient place in this Contingent line, as at V I, to which I apply the ſide of the Board C *e* D, ſo as that the point *e* may ly juſt upon VI in the Contingent line; and having a thred faſtned in the Center of the Semi-Circle of Poſition, I draw that thred ſtraight over the firſt 15 degrees of the Circle of Poſition, numbred from o towards *b*, and where the thred cuts the Contingent line I make a mark, for that mark ſhall be the mark for the 7 a clock line. From thence I remove the thred to 30. degrees of the Semi-Circle, and draw it through the Contingent line, and where it cuts the Contingent line there ſhall be the mark for the 8 a clock line. From thence I remove the thred to 45 degrees of the Semi-Circle and draw it through the Contingent line, and where it cuts the Contingent line there ſhall be the mark for the 9 a clock line. From thence in like manner I remove the thred to 60. and 75. and where the thred cuts the Contingent line ſhall be the mark for 10 and 11 a clock lines; The 12 a clock line cannot be drawn on this Plain, as you may ſee, if you apply the thred to 90 degrees, for though you ſhould draw it out never ſo far yet would it never touch the Contingent line, becauſe it is Parallel to the line *g b*, and lines Parallel never meet.

But becauſe in our Latitude the Sun Riſes before 4. in the Morning, therefore two Hour lines are yet wanting viz. 5 and 4, which I may find either by applying the thred firſt to 15, and next to 30 degrees from o towards *g* in the Semi-Circle, and ſo marking where it cuts the Contingent line, as before: Or elſe by transferring the diſtance of the ſame number of Hour lines from the 6 a clock line already drawn on the ſide *e b*, to the ſide *e g*, as in Prob. 2. of this Book is more fully ſhewed.

Having

Having thus marked out on the Contingent line the diſtances of each Hour; I draw a line parallel to the Contingent line, and draw lines from every Hour markt on the Contingent to croſs the Contingent line at right angles, and continue each line to the line parallel to the Contingent; and theſe lines ſhall be the Hour lines of an Eaſt Plain. To theſe Hour lines I ſet figures, as in the Scheam may be ſeen.

The Style D K of this Dyal (as well as of others) muſt ſtand parallel to the Axis of the World: it muſt be alſo parallel to all the Hour lines, and ſtand directly over the 6 a clock line, and that ſo high as is the diſtance between the Center of the Semi-Circle of Poſition and the point where the 6 a clock line cuts the Contingent line: Or (which is all one) at ſuch an height as when it is laid flat down upon the Plain it may juſt reach the 9 a clock line.

PROB. VII.

To make an Erect Direct Weſt Dyal.

AN Erect Direct Weſt Dyal is the ſame in all reſpects with an Erect Direct Eaſt Dyal; Only as the Eaſt ſhews the Fore-noon Hours, the Weſt ſhews the After-noon Hours.

Thus if you ſhould draw the Eaſt Dyal on any tranſparent Plain, as on Glaſs, Horn, or anoyled Paper, on the one ſide will appear an Eaſt Dyal, and on the other a Weſt. Only the Figures (as was ſaid before) muſt be changed; for that which in the Eaſt Dyal is 11, in the Weſt muſt be 1: that which in the Eaſt Dyal is 10, in the Weſt muſt be 2: that which in the Eaſt Dyal is 9, in the Weſt muſt be 3. &c.

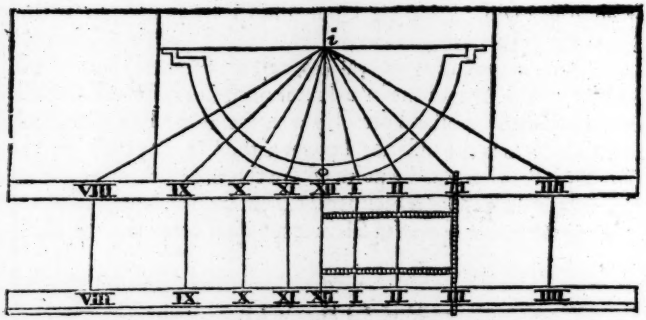
PROB. VIII.

To make a Polar Dyal.

POlar Dyals are Horizontal Dyals under the Equinoctial: They are of the ſame kind with Eaſt and Weſt Dyals; Only whereas Eaſt and Weſt Dyals have but the Hour lines of half the longeſt day diſcribed on them, theſe have all the Hour lines of

of the whole Day; and are marked on both ſides the Noon line: as in the following Figure.

The Style of this Dyal muſt ſtand over the Noon line, Parallel to the Plain; for then it will alſo be parallel to the Axis



of the World: and its heigth above the Plain muſt be the diſtance between the Center *i* of the Semi-Circle and the point in the Contingent line cut by the Noon-line. But I have inſerted the Figure, which alone is ſufficient inſtructions.

PROB. IX.

To make Erect South Dyals, Declining Eaſtwards or Weſtwards.

DRaw on your Plain an Horizontal line, and on it diſcribe a Semi-circle, as you were taught in Prob. 4.

Then Rectifie the Globe, Quadrant of Altitude, Colure, and Hour-Index, as by the ſame Probleme: and bring the lower end of the Quadrant of Altitude to the degree of Declination from the North point in the Horizon Eaſtwards or Weſtwards; for then the Quadrant of Altitude ſhall repreſent a Plain declining from the North Eaſtwards, or Weſtwards accordingly. Then turn the Globe Eaſtwards, till the Index of the Hour-circle points to all the Hours before Noon, and examine in what number of degrees from the Zenith the Colure cuts the Quadrant of Altitude, when the Index points to each Hour, For a line drawn from the Center A through the ſame number

ber of degrees reckoned from the Perpendicular A B, which is the 12 a clock line towards C on the Plain, ſhall be the ſame Hour-lines the Index points at.

Example.

I would make an Erect Dyal declining from the North towards the Eaſt 63. degrees: The Globe, Quadrant of Altitude, Vernal Colure, and Hour-Index Rectified, as before, I bring the lower end of the Quadrant of Altitude to 63. degrees counted from the North point of the Horizon towards the Eaſt: Then

I turn the Globe Eaſtwards till the Index points to	11	a clock, or till 15. deg. of the Equator paſs through the Meridian, and find the Colure cut the Quadrant of Altitude in	9. 43	counted from the Zenith.
	10		19. 0	
	9		25. 57	
	8		35 10	
	7		45. 56	
	6		60. 15	
	5		79. 45	

And theſe are the diſtances of the Fore-noon Hour-lines, which I ſeek in the Weſt ſide of the Plain, *viz.* from B towards C; and through theſe diſtances I draw lines from the Center, and theſe lines ſhall be the Fore-noon Hour-lines.

Now herein is a difference between Declining Dyals, and Direct Dyals: For having found the diſtances of the Hour-lines for one half of the Day, be it either for Before Noon or After Noon in a Direct Dyal, you have alſo found the diſtances for the other half Day; becauſe, as was ſaid Prob. 3. Equal number of Hours have equal diſtance from the Noon line: But in Declining Dyals it is not ſo: Becauſe the Sun remaining longer upon that ſide of the Plain which it declines to, then it doth upon the contrary ſide, there will be a greater number of Hour lines upon it, and by conſequence the diſtance of the Hour lines leſs than on the contrary ſide of the Plain.

Therefore for finding the After Noon Hour lines, I turn about the Quadrant of Altitude upon the Zenith point till the lower end of it come to the degree of the Horizon oppoſite to that degree of Declination that the Quadrant of Altitude was placed at when I ſought the Fore Noon Hour lines, *viz.* to 63. degrees

counted from the South towards the Weſt and bring the Vernal Colure again to the Meridian, and the Index (as before) to 12, Then,

turning the Globe Weſtwards till the Index points to	1 2 3 4	a clock, or till 15. deg. of the Equator paſs through the Meridian, I find the Colure cut the quadrant of Altitude.	11.20 26. 47. 49.20 75. 52

counted from the Zenith.

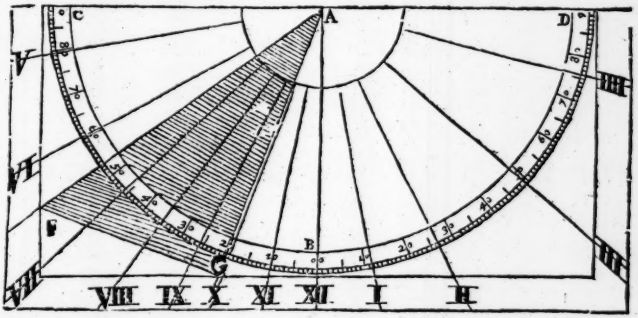
And theſe are the diſtances of the After Noon Hour lines; which diſtances I ſeek in the Eaſt ſide of the Plain, viz. from B towards D (as before) and ſo drawing lines from the Center A through theſe diſtances, I have all the Afternoon Hour lines alſo drawn on my Plain.

You may note, that this Plain is capable to receive no more Hour lines After noon then 4. for when the Colure goes off the Quadrant of Altitude, the Sun goes off theſe kind of Plains.

To theſe Hour lines I ſet their numbers, as you may ſee in the Figure.

Then to find both the diſtances of the Subſtyler line from the 12 a clock line, and the Elevation of the Style above the Plain, Bring the Colure to the number of degrees of the Plains Declination, counted in the Horizon from the South point to the Eaſt point, and the Quadrant of Altitude to the degrees of the Plains Declination, counted in the Horizon from the North point towards the Eaſt, ſo ſhall the Quadrant of Altitude and the Colure cut each other at Right Angles; and the number of degrees comprehended between the Colure and the Zenith in the Quadrant of Altitude, ſhall be the number of degrees between the Subſtyler line and the 12. a clock line, which in this Example is 19. degrees 45 minutes: And the number of degrees comprehended between the Quadrant of Altitude and the Pole, counted in the Colure, ſhall be the number of degrees that the Style is to be Elevated above the Plain; which in this Example is 33. degrees 40 minutes. Wherefore for the diſtance of the Subſtyler line from the 12 a clock line, I count in the Circle from the 12 a clock line in the contrary ſide of the Plain, viz. in the Weſt ſide, (becauſe the Plain declines towards the Eaſt) 19 degrees 45. minutes, as at D, and through that number of degrees and minutes from the Center A, I draw the line A G, which ſhall be the Subſtyler line: And from the Subſtyler line (either way) I number 33. degrees 40 minutes, the Elevation of the Style above the Plain, and through

through thoſe degrees and minutes I draw from the Center A, the line A F, for the Style or Gnomon; Then I let fall the Perpendicular F G upon the Subſtyle A G: So is there a Triangle



made, which if it be erected Perpendicular upon the Subſtyle A G, the Style A F ſhall be Parallel to the Axis of the World, and caſt a ſhadow upon the Hour of the Day.

Here you may ſee that in Declining Dyals the Style doth not ſtand at the ſame Elevation above the Plain, that it doth in Erect Direct Dyals; neither doth it ſtand over the 12 a clock line; but ſwerves from it towards the Quarter of Declination.

PROB. X.

To make a South Erect Dyal, Declining Eaſtwards or Weſtwards.

AS is Prob. 5. an Erect Direct North Dyal hath the ſame Delineation that an Erect Direct South Dyal hath, and differs only in the placing the Figures of the Hour lines: So a South Erect Dyal that declines Eaſtwards, or Weſtwards, differs from a North Erect Dyal that Declines Eaſtward, or Weſtwards, the ſame number of degrees, only in placing the Hour lines at the ſame diſtance on the contrary ſide of the Plain, and by tranſpoſing the Figures of 11 for 1: 10 for 2: 9 for 3. &c.

Thus, if you draw upon Glaſs, Horn, or an Oyled Paper, the North Dyal Declining Eaſtwards, as in the foregoing Probleme,

and place it to its due ſcituation, the back ſide of it ſhall be a South Dyal declining towards the Weſt ſo many degrees as the foreſide Declines towards the Eaſt; and the only difference in it will be the Figures of the Hour lines; as was ſaid before.

PROB. XI.

To make Direct Reclining, *or* Inclining Dyals

DIrect Reclining or Inclining Dyals are the ſame with Erect Direct Dyals that are made for the Latitude of ſome other Places: The Latitude of which Places are either more than the Latitude of your Place, if the Plain Recline, or leſs if the Plain Incline; and the in ſuch a proportion as the arch of Reclination or Inclination of your Plain is.

Thus a Direct South Dyal Reclining 10 degrees in *Londons* Latitude, *viz.* 51½ degrees is an Erect Direct Dyal made for the Latitude of 61½ degrees: And a Direct South Dyal Inclining 10 degrees in the Latitude 51½ degrees is an Erect Direct Dyal in the Latitude 41½. degrees: and is to be made according to the Directions in Prob. 4.

PROB. XII.

To make Declining Reclining *or* Declining Inclining Dyals.

THe diſtances of the Hour lines either for a Declining Reclining Plain, or a Declining Inclining Plain may moſt eaſily be found upon the Plain of the Horizon. That is(as ſome Authors call it)by the Horizontal Dyal, by changing the Circles of ahe Globe one into another: So as the Plain of the Horizon may ſerve to repreſent the Dyal Plain; Yet this way not being natural, becauſe you muſt admit one Circle to be another, and that in Young Learners might ſometimes breed a little difficulty, *Gemma Friſius*, *Metius*, and *Blaew* hath preſcribed a thin Braſs plate to be made equal to a Semi-Circle of the Equinoctial, and divided from the middle point of it either way into 90 degrees, which may not unproperly be calleda *Gnomonical Semi-Circle*. This Semi-Circle muſt be bowed cloſe

to

to the Body of the Globe into a Semi-Circular form, and ſo ſet to any Reclination or Inclination, and then it will repreſent a Reclining or Inclining Plain: And by the motion of the Colure through the ſeveral degrees of this Semi Circle the diſtances of the Hour lines may be found: Thus.

The Globe, Quadrant of Altitude, Colure, and Hour Index Rectified; as by Prob. 4. Bring the lower end of the Quadrant of Altitude to the degree in the Horizon of the Plains Declination, if your Plain be a South Declining Incliner, or a North Declining Recliner, and count on the Quadrant of Altitude from the Zenith downwards the number of degrees of Reclination, or Inclination, and to that number of degrees bring the middle of the Gnomonical Semi Circle, and let the ends of it cut the Horizon on either ſide in the degrees of the Plains Azimuth, ſo ſhall the Gnomonical Semi-Circle repreſent your Reclining or Inclining Plain. And ſo oft as 15. degrees of the Equator paſſes through the Meridian, ſo oft ſhall you enquire what degrees of the Gnomonical Semi-Circle the Colure cuts; for ſo many degrees aſſunder muſt the ſeveral reſpective Hour lines of a Reclining Declining Plain be in a Semi Circle divided into 180. degrees.

But if your Plain be a South Declining Recliner, or a North Declining Incliner; Bring the Quadrant of Altitude to the degree of the Horizon oppoſite to the degree of the Plains Declination, (becauſe the upper ſide of the Plain lies beyond the Zenith) counted from the South point in the South Recliners: and from the North point in North Incliners.

Then find the heigth of the Style, and place of the Subſtyle: thus, Keep your Gnomonical Semi-Circle in its poſition: But turn the Quadrant of Altitude about on the Zenith point till the lower end of it comes to the degree of the Horizon oppoſite to the degree it was placed at before, and turn about the Globe till the Colure cut the Quadrant of Altitude above the Horizon in the number of degrees the Plain Reclines from the Zenith; ſo ſhall the Colure cut the Gnomonical Semi-Circle at Right Angles; then count the degrees contained between the middle of the Gnomonical Semi-Circle and the Colure, for that number of degrees is the diſtance of the Subſtile from a Perpendicular line in the middle of your Plain, and muſt be placed Weſtwards of the ſaid Perpendicular, if your Plain decline from the South Eaſtwards; or Eaſtwards, if your Plain decline from the South Weſt-

wards. Then obſerve how many degrees are contained between the Semi-Circle and the Pole; for that number of degrees is the number of degrees that the Style is to be Elevated above the Subſtyle.

Example.

Here at *London*, I would make a Dyal upon a Plain Declining from the South Eaſtwards 30 degrees, and Reclining from the Zenith 20. degrees; *Londons* Latitude is 51 ½ degrees: Therefore, Having on the Plain diſcribed a Semi Circle, &c. as was directed Prob. 4 I Rectifie the Globe, Quadrant of Altitude, Colure and Hour Index, as by the ſame Probleme, and bring the lower end of the Quadrant of Altitude to 30. degrees from the North point of the Horizon towards the Weſt becauſe that is the degree oppoſite to the degree of the Plains Declination, viz. to 30 degrees from the South Eaſtwards, and I bring the middle of the Gnomonical Semi-Circle to 20 degrees of the Quadrant of Altitude counted from the Zenith downwards towards the Horizon and the ends of the Gnomonical Semi-Circle to the degrees of Azimuth the Plain lies in in the Horizon, viz. to 30 degrees from the Eaſt point Northwards, and to 30 degrees from the Weſt point Southwards, ſo ſhall 11. degrees 10. minutes of the Gnomonical Semi Circle be comprehended between the Quadrant of Altitude and the Braſen Meridian: Theſe 11. degrees 10 minutes ſhews that the 12 a clock line is diſtant from the Perpendicular A B 11. degrees 10. minutes: Then to find all the Fore Noon Hour lines,

I turn the Globe Eaſtwards till the Index points to	11	a clock: or till 15 deg. of the Equator paſs through the Meridian; & find the Colure cut the Gnomon Semi-Circle in	15. 8	counted from the middle of the Gnomonical Semi-Circle.
	10		18. 56	
	9		22. 37	
	8		26. 52	
	7		32. 37	
	6		42. 5	
	5		62. 43	

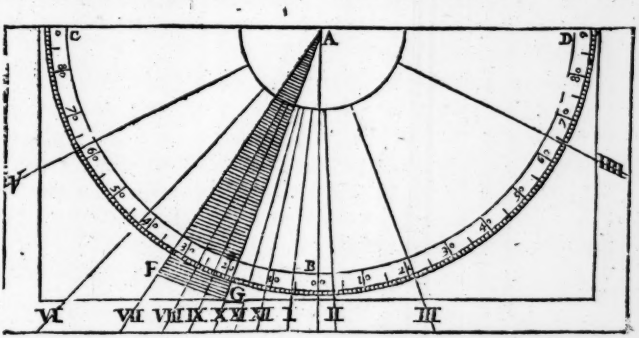
And theſe are the diſtances of the Fore Noon Hour lines; to which diſtances you may ſet Pricks on the Weſt ſide the Semi-Circle of the Plain, viz. from B to C.

The

The After Noon Hour lines are found by bringing the Colure again to the Meridian, and the Index of the Hour Circle to 12. for then

turning the Globe Weſtwards till the Index points to	1	a clock, or till 15 deg. of the Equator paſs through the Meridian, I find the Colure cut the Gnomon. Semi-Circle in	5. 45	counted from the middle of the Gnomon. Semi-Circle.
	2		2. 54	
	3		20. 52	
	4		64 36	

And theſe are the diſtances of the After-noon Hour-lines; and muſt all but the 1 a clock Hour-line be prickt down at their reſpective diſtances on the Eaſt ſide the Plain, viz. from B to D: But becauſe the Colure comes not to the middle of the Gnomonical Semi-Circle before the firſt 15. degrees of the Equator paſs through the Meridian after 12. therefore the 1 a clock muſt ſtand 5. degrees 45. minutes on the Weſt ſide of the Plain: And for this cauſe I made diſtinction with a line between the 1 a clock



and the 2 a clock, in the foregoing Table. Then I draw lines from the Center A through every one of theſe pricks in the Semi-Circle, and they ſhall be the Hour lines of this Declining Reclining Plain.

Having drawn the Hour-lines, I remove the Quadrant of Altitude to the degree of the Horizon oppoſite to the degree it was at before, viz. to 30. degrees from the South Eaſtwards, which is ſo much as the Plain declines Eaſtwards; But I let the Gnomonical Semi-Circle ſtand as it did: And turning about the Globe

Globe till the Colure cut the Quadrant of Altitude in 20. degrees counted from the Horizon upwards, *viz.* the degrees of Reclination, I find 18. degrees 40. minutes contained between the middle of the Gnomonical Semi-Circle and the Braſen Meridian, which is the diſtance of the Subſtyle from the Perpendicular; And I find the Gnomonical Semi-circle cut the Colure in 13. degrees 49. minutes from the Pole, which is the Height that the Style muſt be raiſed over the Subſtyle; Therefore I prick off in the Semi-Circle on the Plain, the diſtance of the Subſtyle 18. degrees 40 minutes from the Perpendicular Weſtward, becauſe this Plain declines Eaſtwards: And from the Center A, I draw through that prick the line A E, which ſhall be the Subſtyle, and from this Subſtyle (either way) I count in the Semi-Circle on the Plain 13. degrees 49. minutes, and there make a Prick: Then from the Center A, I draw through that Prick the line A F, to repreſent the Style or Gnomon: Then I let fall the Perpendicular F G upon the Subſtyle A G; So is a Triangle made; which if it be erected Perpendicularly upon the Subſtyle A G, the Style A F ſhall be Parallel to the Axis of the World, and caſt a ſhadow upon the Hour of the Day.

Having made this Dyal, you have made four ſeveral Dyals, whereof this is one: And his oppoſite, viz. North Declining Weſtwards 30 degrees Inclining to the Horizon 70. degrees is another. The South Declining Weſtwards 30. degrees Reclining from the Zenith 20. degrees is another: And his oppoſite, viz. North Declining Eaſtwards 30. degrees Inclining to the Horizon 70 degrees is the other.

PROB. XIII.

To make a Dyal *upon a* Declining Inclining Plain.

THe Precepts for making theſe Dyals are delivered in the foregoing Probleme: Therefore we ſhall at firſt come to an Example.

I would make a Dyal upon a Plain in *Londons* Latitude Declining from the South Weſtwards 25. degrees and Inclining towards the Horizon by the ſpace of an Arch containing 14. degrees. Having firſt diſcribed on the Plain a Semi-Circle, as was directed Prob. 4. I rectifie the Globe, Quadrant of Altitude,

Altitude, Colure, and Hour-Index, as by the ſame Probleme, and bring the lower end of the Quadrant of Altitude to the degree of the Plains Declination, viz. to 25 degrees counted from the South Weſtwards, and the ends of the Gnomonical Semi Circle to the degrees of Azimuth between which the Plain lies, viz. to 25 degrees from the Weſt Northwards, and 25 degrees from the Eaſt Southwards; and the middle of the Gnomonical Semi Circle to the degree of the Plains Inclination, viz 14 degrees counted from the Zenith downwards on the Quadrant of Altitude: Then counting the degrees of the Gnomonical Semi Circle contained between the middle of the ſame and the Brazen Meridian, I find 5 degrees 30 minutes; Therefore I number in the Semi Circle deſcribed on the Plain from the Perpendicular Weſtwards 5 degrees 30 minutes, viz. from B to C, and there place the 12 a clock line. For finding all the Fore-Noon Hour diſtances

I turn the Globe Eaſtwards till the Index points to	11	a clock, or till 15 deg. of the Equa. paſs through the Merid. and find the Colure cut the Gnomon. Semi circle in	20. 5	counted from the middle of the Gnomon. Semi circle.
	10		36. 7	
	9		56. 24	
	8		76 31	

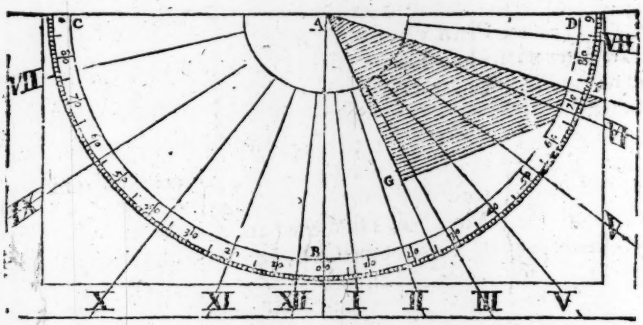
And theſe are the diſtances of all the Fore Noon Hour lines; to which ſeveral diſtances I make pricks on the Weſt ſide the Semi circle on the Plain. viz. from B to C.

The after noon Hour lines are found by bringing the Colure again to the Meridian, and the Index of the Hour circle to 12. For then

turning the Globe Weſtwards till the Index points to	1	a clock, or till 15. degrees of the Equator paſs through the Meridian, I find the Colure cut the Gnomonical Semi-circle in	6. 20	counted from the middle of the Gnomonical Semi-circle.
	2		18. 2	
	3		28. 45	
	4		39. 56	
	5		52. 30	
	6		67. 19	
	7		84. 13	

And theſe are the diſtances of the after noon Hour lines, which I alſo prick down at their reſpective diſtances from the Perpendicular Eaſtwards, viz. from B towards D on the Plain; and by drawing lines from the Center A through all the pricks, I have all the Hour lines that this Plain will admit of.

Having drawn the Hour lines, I remove the lower end of the Quadrant of Altitude to the degree of the Horizon opposite to the degree it was at before, viz. to 25. degrees from the North Eastwards, which is so much as the Declination is Westward; but I let the Gnomonical Semi-Circle stand as it did, and turn about the Globe till the Colure cuts the Quadrant of Altitude in 14. degrees counted from the Horizon upwards, which is the Inclination of the Plain: Then I find 24. degrees 3. minutes comprehended between the middle of the Gnomonical Semi-Circle and the Brasen Meridian, which is the distance of the Substyle from the Perpendicular: and this distance I count Westwards on the Plain, because the middle of the Semi-Circle lies Westwards on the Globe, and draw the line A G through it for the Substyle: And I find the Gnomonical Semi-Circle cut the Colure in 48. degrees 5. minutes, for the Heigth that the Style must be Elevated over the Substyle: Therefore I make a prick on the Plain 48. degrees 5. minutes distant from the Substyle, and through that prick I draw the line A F to represent the Style or Gnomon; Then I let fall the Perpendicular F G upon the Substyle A G, so is there a Triangle made; which if it be erected



Perpendicularly upon the Substyle A G, the Style A F shall be Parallel to the Axis of the World, and cast a shadow upon the Hour of the Day.

Having made this Dyal you have also four Dyals made; as well as in the former Probleme: For this is one; and its opposite viz. North declining Eastwards 25. degrees Reclining 76. degrees is another; The South declining Eastwards 25. degrees Incli-

Inclining 14. degrees is another; and its oppoſite, viz. North declining Weſtwards 25. degrees Reclining 76. degrees is another.

PROB. XIV.

To find in what Place of the Earth *any manner of Plain that in your* Habitation *is not* Horizontal, *ſhall be* Horizontal.

IT was ſaid in the *Preface* that all manner of Plains however ſcituate are Parallel to ſome Country or other on the Earth: Therefore all manner of Plains are indeed Horizontal Plains and the diſtances of the Hour lines to be diſcribed on them may be found as the diſtances of the Hour lines of the Horizontal Dyal in Prob. 3. It reſts now to learn in what place of the Earth any Plain that is not Horizontal in your Habitation ſhall become Horizontal: And for help of your underſtanding herein, Take theſe following Rules.

1. If your Plain be Erect Direct North, or South, it ſhall be an Horizontal in the ſame Longitude at 90. degrees diſtance on the Meridian, (counted from the Zenith of your Place,) through the Equinoctial. See an Example of this in Prob. 4. where I have reduced an Erect Direct Dyal, to an Horizontal. Thus an Erect Plain under the Pole is an Horizontal under the Equator; and an Erect Direct in 80. degrees North Latitude is in the ſame Longitude an Horizontal at 10. degrees South Latitude: An Erect Direct in 70. degrees North Latitude, is in the ſame Longitude, an Horizontal at 20. degrees South Latitude: and ſo to any other degrees of Latitude (as aforeſaid) till you come to 45. degrees Latitude: where an Erect is an Horizontal, and an Horizontal an Erect: Only as the Hour lines of the Horizontal (being turned downwards) are numbred from the right hand towards the left, in the Erect Direct Dyal they are numbred from the left hand towards the Right.

2. If your Plain be Erect Declining, it ſhall be an Horizontal Plain at that point on the Globe which is againſt the degree of Declination, found in the Horizon.

But note, If your Plain declines Weſtwards, the Sun comes ſooner to the Meridian of it, than to the Meridian of the Place

where it becomes an Horizontal Plain, and that by ſo many Hours or minutes as the degrees of the difference of Longitude between the two places converted into Time amounts to. If it declines Eaſtward, the Sun comes ſo much later to the Meridian of it: And for this Cauſe (though the making this Dyal be the ſame with an Horizontal Dyal for another Place, yet in Reſpect of Time) there will be a difference between them.

Example.

I would make the North Dyal Declining Eaſt 63. degrees, as in Prob 9. by the Plain of the Horizon: Firſt I ſeek in what Place of the Earth it ſhall become an Horizontal plain: Thus, I Elevate the Pole of the Globe 51½ degrees above the Horizon, and bring the Vernal Colure to the Meridian, then I count from the South point in the Horizon Eaſtwards 27 degrees, and on the point on the Globe directly againſt thoſe 27. degrees I make a prick for the Place where a Plain that declines 63. degrees from the North Eaſtwards at *London* ſhall be Horizontal; or which is all one, this Declining Plain at *London* ſhall ly in the Horizon of that Prick: This Prick for diſtinction ſake we ſhall hereafter call the Horizontal Place: Then by Prob. 1. of the Second Book, I examine the Latitude and Longitude of this Horizontal Place, and find Latitude 33. 40. South; and Longitude from the Colure 33. degrees, which is the difference of Longitude between *London* and the Horizontal Place: which being converted into Time by allowing for every 15. degrees 1. hour of Time gives 2. hours 12. minutes that the Sun comes ſooner to the Meridian of the Horizontal Place, then to the Meridian of the Plain at *London*: ſo that when it is 12. a clock there, it will be but 9. a clock 48. minutes here; when 12 a clock here, it will be 2. a clock 12. minutes There, &c.

Having thus found in what Longitude from *London* and Latitude this plain is Parallel to the Horizon, I ſeek the diſtances of the Hour-lines upon the Plains of the Horizon Thus, I Elevate the Pole of the Globe to the Height of the Pole in the Horizontal Place, viz. 33. degrees 40. minutes, and bring the Horizontal Place on the Globe to the Meridian, and the Index of the Hour Circle to 12. Then I examine the degree of the Horizon the Colure cuts, and find it 19 ¼. from the South Weſtwards, This 19¼ degrees

degrees repreſents the Meridian line of the Horizontal Place: And alſo the Subſtilar line here at *London*; Therefore this 19¼. degrees I count from the Perpendicular A B of the Plain, and from the Center A draw the line A G through them; Becauſe from this line on the Plain all the hour lines muſt be numbred, and not (as all along hitherto) from the Perpendicular of the Plain. Then

turning the Globe Eaſtwards till the Index points to	11	a clock: or till 15 deg. of the Equator paſs through the Meridian; I find the Colure cut the Horiz. in	10. 2	counted from the Meridian.
	10		0. 45	
	9		6. 12	
	8		15. 25	
	7		26. 11	
	6		40. 30	
	5		60. 0	

And theſe are the diſtances of the Forenoon Hour lines: which diſtances I transfer by pricks to the Plain. But as in Prob. 9. I ſought the diſtances from the Perpendicular on the Plain, ſo now in this Caſe (as was ſaid before) I ſeek them from the Subſtyle, and through theſe pricks I draw lines from the Center, as in other Dyals, and theſe lines ſhall be the Fore-Noon Hour lines.

To Find the Afternoon Hour diſtances, I bring the Horizontal Place on the Globe again to the Meridian, and the Index of the Hour Circle to 12. and

turning the Globe Weſtwards till the Index points to	1	a clock, or till 15 deg. of the Equator paſs through the Meridian, I find the Colure cut the Horizon in	31. 5	counted from the Meridian.
	2		46. 32	
	3		68. 5	
	4		95. 37	

And theſe are the diſtances of all the Afternoon Hour lines; which I alſo transfer to the Plain, counting them from the Subſtyle, and draw lines from the Center A through theſe diſtances; and theſe lines ſhall be the Afternoon Hour lines.

Then from the Subſtyle I count the degrees and minutes of the Latitude of the Horizontal Place, viz. 33 degrees and through theſe degrees and minutes I draw the line A F from the Center A for the Style: Then from the Style I let fall the Perpendicular F G upon the Subſtyle, ſo is there a Triangle made; which if it be erected perpendicularly upon the Subſtyle A G, the Style A F ſhall be parallel to the Axis of the World, and caſt a ſhadow upon the Hour of the Day.

3. If your Plain be a Direct Recliner, Seek in the Longitude of your Place the Complement to 90. of your plains Reclination: For there a Direct Recliner becomes an Horizontal Plain.

4. If your Plain be a Declining Recliner: The Globe and Quadrant of Altitude Rectified, Bring your Habitation on the *Terestrial* Globe to the Meridian, and the Quadrant of Altitude to the Declination, as by the ſecond Rule in this Probleme; and count upwards on the Quadrant of Altitude the Reclination, and there make a prick on the Globe by the ſide of the Quadrant of Altitude, for at that prick on the Globe the Declining Recliner ſhall become an Horizontal Plain; then examine the Latitude of that prick as by Prob. 1. of the ſecond Book, and the difference of Longitude as by Prob. 9. of the third Book, and convert the difference of Longitude into Time, by allowing for every 15 degrees 1. Hours Time, for every degree 4. minutes Time, and ſo proportionably, ſo ſhall you know what Hours and minutes the Sun comes ſooner or later to the Meridian of your Habitation than to the Meridian of that Place where it becomes an Horizontal Plain; Sooner, if the Globe were turned Eaſtwards; but Later if it were turned Weſtwards.

Having thus found out where this Plain becomes Horizontal, make your Dyal to this Plain, as by the ſecond Rule in this Probleme: Find alſo the Style as is there directed.

5. If your Plain be a Declining Incliner, the Globe and Quadrant of Altitude Rectified, Bring the Colure to the Meridian, and the Quadrant of Altitude to the degree of the Horizon oppoſite to the degree of the Plains Declination, and count upwards on the Quadrant of Altitude the degrees of Inclination, and make a pirck there; For in the Antipodes of that prick (found as by Prob. 29. of the ſecond Book) that Declining Incliner ſhall become an Horizontal Plain. Then find the Latitude and difference of Longitude of this Antipodes, by the former Rule, and make a Dyal to that Plain, as by the ſecond Rule in this Probleme. Find alſo the Style as therein is directed.

PROB.

PROB. XV.

To make a Dyal *on the* Ceeling *of a* Room, *where the* Direct Beams *of the* Sun *never come.*

FInd ſome convenient place in the Tranſum of a Window to place a ſmal round peece of Looking-Glaſs, about the bigneſs of a Groat, or leſs, ſo as it may ly exactly Horizontal: The point in the middle of this Glaſs we will mark A, and for diſtinctions ſake (with Mr *Palmer*) call it Nodus Through this Nodus you muſt draw a Meridian line on the Floor, Thus: Hang a Plumb line in the Window exactly over Nodus, and the ſhadow that the Plumb line caſts on the Floor juſt at Noon will be a Meridian line; Or you may find a Meridian line otherwiſe, as by the *Preface.* Having drawn the Meridian line on the Floor; find a Meridian line on the Ceeling, thus: Hold a Plumb line to the Ceeling, over that end of the Meridian line next the Window; If the Plumbet hang not exactly on the Meridian line on the Floor, remove your hand on the Ceeling one way or other, as you ſee cauſe till it do hang quietly juſt over it, and at the point where the Plumb line touches the Ceeling make a mark, as at B, that mark B ſhall be directly over the Meridian line on the Floor: then remove your Plumb line to the other end of the Meridian line on the Floor, and find a point on the Ceeling directly over it, as you did the former point, as at C, and through theſe two points B and C on the Ceeling ſtrain and ſtrike a line blackt with Smal-Coal or any other Culler, as Carpenters do) and that line B C on the Ceeling ſhall be a Meridian line as well as that on the Floor: Then examine the Altitude of the Equinoctial as by Prob. 6. of the ſecond Book you did the Meridian Altitude of the Sun; and faſten a ſtring juſt on the Nodus, and remove that ſtring in the Meridian line on the Ceeling till it have the ſame Elevation in a Quadrant, that the Equinoctial hath in your Habitation; and through the point where the ſtring touches the Meridian line in the Ceeling ſhall a line be drawn at right Angles with the Meridian, to repreſent the Equinoctial line. Thus in our Latitude the Elevation of the Equator being $38\frac{1}{2}$ degrees; I remove the ſtring faſtned to the Nodus forwards or backwards in the Meridian line of the Ceeling, till the Plumb line of a

Quadrant

Quadrant when one of the ſides are applyed to the ſtring, fals upon 38½ degrees: and then I find it touch the Meridian line at D in the Ceeling: therefore at D I make a mark, and through this mark ſtrike the line D E (as before I did the Meridian line) to cut the Meridian line at Right Angles: This line ſhall be the Equinoctial line.

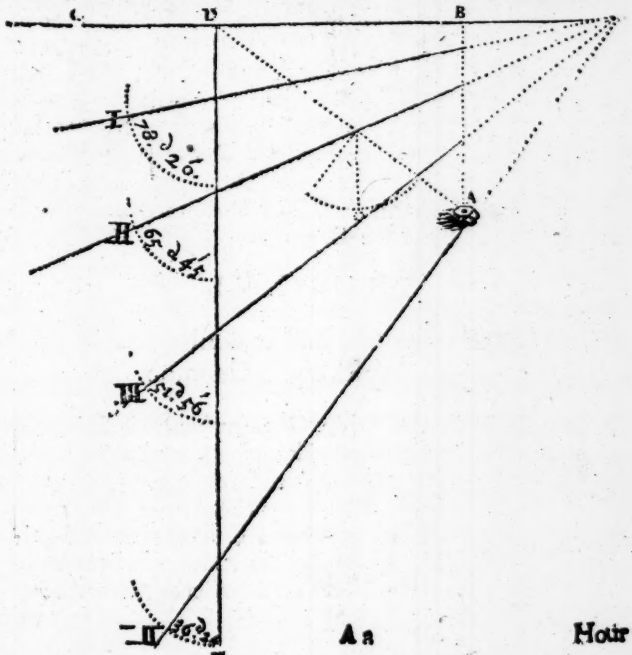
Then I place the Center of the Semi-Circle of Poſition upon Nodus, and under-prop it ſo that the flat ſide of it may ly Parallel to the ſtring when it is ſtrained between the Nodus and the Equinoctial, and alſo ſo as the ſtring may ly on the diviſion of the Semi-Circle marked o, when it is held up to the Meridian line in the Ceeling: Then removing the ſtring the ſpace of 15. degrees in the Circle of Poſition to the Eaſtwards, and extending it to the Equator on the Ceeling, where the ſtring touches the Equator there ſhall be a point through which the 1 a clock Hour-line ſhall be drawn: and Removing the ſtring yet 15 degrees further to the Eaſtwards in the Semi-Circle of Poſition, and extending it alſo to the Equator, where it touches the Equator there ſhall be a point through which the 2 a clock Hour-line ſhall be drawn. Removing the ſtring yet 15 degrees further to the Eaſtwards in the Semi-Circle of Poſition, and extending it to the Equator, there ſhall be a point through which the 3 a clock Hour line ſhall be drawn: The like for all the other After-Noon Hour lines; ſo oft as the ſtring is removed through 15. degrees on the Semi Circle of Poſition, ſo oft ſhall it point out the After-Noon diſtances in the Meridian line on the Ceeling.

The ſcituation of the Semi Circle of Poſition cannot conveniently be ſhewn in this Figure, unleſs it be drawn by the Rules of Perſpective; Neither if it were would it ſuit with the other demonſtrations, except they were drawn by the ſame Rules alſo; which to do would be hard for young Learners to underſtand: Therefore I have left out the Semi Circle of Poſition in this Figure, and refer you for a demonſtration thereof to the ſixth Problem; For even as the lines drawn through every 15 degrees of the Semi-Circle there denote in a Contingent line the diſtance of any Hour line from the Meridian line, even ſo a line drawn through every 15 degrees of the Semi Circle of Poſition poſed (as aforeſaid) point out in the Equinoctial line on the Ceeling the diſtance of each reſpective Hour line from the Meridian line.

Having

Having thus found out the points in the Equator through which the after noon Hour-lines are to be drawn, I may find the fore-noon Hour diſtances alſo the ſame way, viz. by bringing the ſtring to the ſeveral 15 degrees on the Weſt ſide the Semi Circle of poſition; or elſe I need only meaſure the diſtances of each Hour diſtance found in the Equator from the Meridian line on the Ceeling; for the ſame number of Hours from 12 have the ſame diſtance in the Equinoctial line on the other ſide the Meridian both before and after noon: The 11 a clock Hour diſtance is the ſame from the Meridian line with the 1 a clock diſtance on the other ſide the Meridian, the 10 a clock diſtance the ſame with the 2 a clock diſtance, the 9 with the 3, &c And thus the diſtances of all the Hour lines are found out on the Equator.

Now if the Center of this Dyal lay within doors, you might draw lines from the Center through theſe pricks in the Equator, and thoſe lines ſhould be the Hour lines, as in other Dyals: But the Center of this Dyal lies without doors in the Air, and therefore not convenient for this purpoſe: ſo that for drawing the



Hour lines you muſt conſider what angle every Hour line in an Horizontal Dyal makes with the Meridian; that is, at what diſtance in degrees and minutes the Hour lines of an Horizontal Dyal cut the Meridian; which you may examine as by Prob. 3. for an Angle equal to the Complement of the ſame Angle, muſt each reſpective Hour line with the Equator on the Ceeling have.

Thus upon the point markt for each Hour diſtance in the Equinoctial line on the Ceeling I deſcribe the Arches I, II, III, IIII, as in the Figure, and finding the diſtance from the Meridian of the Hour lines of an Horizontal Dyal to be according to the third Probleme. Thus

The { 1, 2, 3, 4 } a clock Hour-line { 11.40, 24.15, 38. 4, 53.36 } whoſe Complement to 90. is { 78.20, 65.45, 51.56, 36.24 }

I meaſure in a Quadrant of the ſame Radius with thoſe arches already drawn from the Equinoctial line

for the { 1, 2, 3, 4 } a clock Hour { 78.20, 65.45, 51.56, 36.24 }

and transfer theſe diſtances to the Arches drawn on the Ceeling: For then ſtraight lines drawn through the mark in the Arch, and through the mark in the Equator, and prolonged both waies to a convenient length, ſhall be the ſeveral Hour lines (aforeſaid;) And when the Sun ſhines upon the Glaſs at Nodus, its Beames ſhall reflect upon the Hour of the Day.

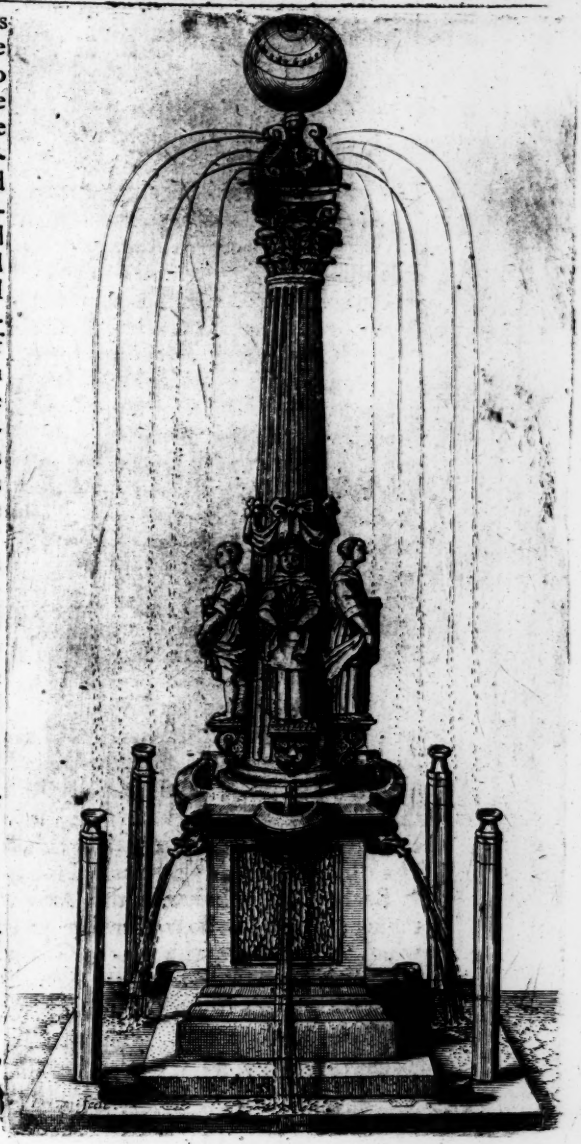
PROB. XVI.

To make a Dyal *upon a ſolid* Ball *or* Globe, *that ſhall ſhew the* Hour *of the* Day *without a* Gnomon.

THe Equinoctial of this Globe or (which is all one) the middle line muſt be divided into 24 equal parts and marked with 1, 2, 3, 4, &c. to 12. and then beginning again with 1, 2, 3, &c. to 12. Then if you Elevate one of the Poles ſo many deg. above an Horizontal line as the Pole of the World is Elevated above the Horizon in your Habitation, and place one of the 12. directly to behold the North, and the other to behold the South: when

when the Sun ſhines on it the Globe will be divided into two halfs, the one enlightned with the Sun-ſhine, and the other ſhadowed: and where the enlightned half is parted from the ſhadowed half there you ſhall find in the Equinoctial the Hour of the Day; and that on two places on the Ball; becauſe the Equinoctial is cut in two oppoſite points by the light of the Sun.

A Dyal of this ſort was made by Mr *John Leek*, and ſet up on a Compoſite Columne at *Leaden Hall* Corner in *London*, in the *Majoralty* of Sr *John Dethcik* Knight The Figure whereof I have inſerted, becauſe it is pretty peece of Ingenuity, and may perhaps ſtand ſome Lover of Art in ſtead, either for Imitation, or help of Invention.



PROB. XVII.

To make a Dyal upon a Glaſs Globe, whoſe Axis ſhall caſt a ſhadow upon the Hour of the Day.

Firſt divide the Equinoctial of your Globe into 24 equal parts; and having a Semi circle cut out of ſome Braſs plate, or thin wood, to the ſame Diameter your Globe is of, or a very little wider: Apply this Semi circle to the Globe, ſo as the upper edge of each end of the Semi circle may touch the Poles of the Globe, and the middle of the Semi circle may at the ſame edge cut through ſome diviſion made in the Equinoctial: for then a line drawn by the edge of the Semi circle thus poſited ſhall be a Meridian line: The ſame way you muſt draw Meridian lines through every diviſion of the Equinoctial, and ſet figures to them, beginning with 1, 2, 3, 4, &c. to 12. and then beginning again with 1, 2, 3, 4, &c to 12. again. This Globe being made of Glaſs, and having an Axis of wyer paſſing through it from Pole to Pole, will be an Horizontal Dyal all the World over, if its Axis be ſet Parallel to the Axis of the World in the ſame Place; and one of the Meridians marked 12. be ſet ſo as it may directly behold the North point in heaven, and the other the South point in Heaven; for then the Axis of the Globe ſhall caſt a ſhadow upon the Hour of the Day.

And if you divide the upper half of the Glaſs Globe from the under half, when the Axis ſtands Parallel to the Axis of the World, by a Circle drawn round about the Globe, that Circle ſhall repreſent the Horizon; and the Meridian lines drawn on the Globe ſhall be the Hour lines, and have in the Horizontal Circle the ſame diſtance from the 12 a clock line that the ſame reſpective Hour line was found to have, as by Prob. 3. of this Book.

But becauſe the ſhadow of this Axis will not be diſcerned through the Glaſs Body, therefore you may with water and white Lead ground together lay a Ground on the Inſide of the under half of the Glaſs to the Horizontal Circle (as Looking-glaſs makers do their Looking Glaſſes with Tinfoil) for then the ſhadow will appear.

Such a Glaſs Globe Dyal had *Robert Titchborn*, once Lord Maior of *London*, ſtanding in his Garden, ſupported by *Atlas*.

The End of the Fifi Book. The

The Sixth BOOK,

Shewing the Practical Uſe of the

GLOBES.

Applying them to the Solution of

Spherical Triangles.

PRÆFACE.

THe *Solution of* Spherical Triangles *is to know the length of its Sides, and the width of its Angles. Theſe have already by many learned Men been taught, to be performed by a* Canon *of* Sines *and* Tangents; *and alſo by many Inſtruments ſome ſerving as Tables of* Sines *and* Tangents, *ſuch as are the* Sectors, Scales, *the* Spiral line, *&c. and others ſerving to repreſent the* Globe; *ſuch as be the* Mathematical Jewel, Aſtrolabium Catholicum, *and ſeveral other Projections of the* Sphear. *But none hath as yet taught the Solution of* Spherical Triangles *by the* Globe *it ſelf; though it be the moſt natural, and moſt demonſtrative way of all, and indeed ought firſt to be learnt before the Learner enters upon any other way.*

To this Authors of Trigonometry *agree, for the moſt of them in their Books give Caution that the Learner be already ſufficiently*

ſufficiently grounded in the Principles of the Globe: *For thoſe* Lines *or* Circles *which either in Tables or other Inſtruments you force your Imagination to conceive repreſents your* Line *or* Circle *in queſtion, thoſe* Lines *and* Circles (*I ſay*) *you have Actually and Naturally diſcribed on the* Globe, *and therefore may at a ſingle Operation, or perhaps only by a ſudden inſpection, have an Anſwer annexed, according as the nature of your Queſtion ſhall require: and that more Copiouſly than by* Tables *of* Sines *and* Tangents: *For therein you find but one Queſtion at once reſolved: but by the* Globe *you have alwaies two reſolved together.*

Of the Parts and Kindes of Spherical Triangles.

THEOREMS.

1. ALL Spherical Triangles are made of ſix parts; Three Sides and three Angles. The ſides are joyned together at the Angles, and meaſured by degrees of a Great Circle from one end to the other. The Angles are the diſtance of the two joyned ſides: and they are alſo meaſured by an Arch of a Circle, diſcribed on the Angular point. If any three of theſe parts be known, the reſt may be found.

2. All Spherical Triangles are either Right Angled or Oblique Angled. A Right Angle containes 90 degrees: An Oblique Angle either more, or leſs.

3. If a Spherical Triangle have one or more Right Angles; it is called a Right Angled Spherical Triangle. But if it have no Right Angle; it is called an Oblique Angled Spherical Triangle.

4. If an Oblique Spherical Triangle have one Angle greater than a Right Angle: it is called an Obtuſe Angled Spherical Triangle. But if it have no Angle greater, it is called an Accute Angled Spherical Triangle.

5. In Right Angled Triangles the ſides including the Right Angle are called Legs: And the ſide oppoſite to the Right Angle

gle is called Hypothenusa. Thus the sides A B and A C in the following Triangle are called Legs; and the side B C is called Hypothenusa.

6. In a right angled Spherical Triangle one of the Legs are called Base; the other Perpendicular: Thus the Leg B A is Base; and the Leg C A Perpendicular. But the terms may be varyed: for the Base may be made Perpendicular, and the Perpendicular Base. Also One of the adjacent angles is called the Angle at the Base; the other the angle at the Perpendicular: Thus the angle B is called the Angle at the Base: the Angle C the Angle at the Perpendicular.

PROB. I.

The Legs *of a* Right Angled Spherical Triangle *given, to find the* Hypothenusa, *and the two other* Angles.

NOTE. THe Base of a right angled Spherical Triangle shall in this following Treatise be alwaies placed on a Meridian, the Perpendicular on the Equator, the Hypothenusa on the Quadrant of Altitude, and the angle at the Base shall be measured in an arch of the Horizon.

Elevate the Equinoctial into the Zenith, so shall the Poles of the Globe ly in the North and South points of the Horizon.

Then count from the Equinoctial on the first Meridian, if you use the Terrestrial Globe; or on the Vernal Colure, if you use the Celestial, because they are divided from the Equinoctial either way into 90 degrees; and because from thence the degrees of the Equinoctial are begun to be numbred: Count (I say) from the Equinoctial the number of degrees the Base contains and there make a prick: Then count in the Equinoctial from the first Meridian the number of degrees the Perpendicular contains, and make there a second prick: Bring that second prick to the brazen Meridian, so shall the first Meridian be separated from the brazen Meridian by the quantity of an arch equal to the measure of the Perpendicular: Then having the Quadrant of Altitude screwed in the Zenith, turn it about till the side of it cut the prick made in the first Meridian; so shall the

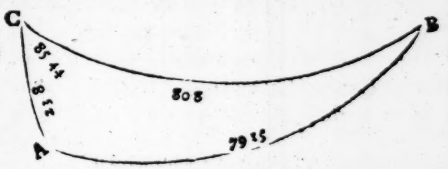
Triangle

Triangle be repreſented on the Globe. The Baſe ſhall ly on the firſt Meridian between the Equinoctial and the Quadrant of Altitude, the Perpendicular in the Equinoctial between the firſt Meridian and the Braſen Meridian; and the Hypothenuſa on the Quadrant of Altitude between the Zenith and the firſt Meridian; and the number of degrees between each of theſe reſpective Arches ſhall be the meaſure of each reſpective Side. For the Angles; The Right Angle is known to be 90 degrees, by the ſecond Theorem in the Preface. The meaſure of the Angle at the Perpendicular is numbred between the Eaſt point in the Horizon, and the graduated edge of the Quadrant of Altitude: But to find the Angle at the Baſe you muſt turn the Triangle, making the Perpendicular Baſe, and the Baſe Perpendicular.

Example.

Having the two Legs given A B 79. degrees 15 minutes, and C A 23. degrees 8 minutes, I would find the meaſure of the Hypothenuſa C B, and the Angles B, C.

The Equinoctial Elevated as before, I make A B Baſe, and C A Perpendicular counting in the firſt Meridian from the Equinoctial 79. degrees 15. minutes and there I make a prick: Then I number in the Equinoctial from the firſt Meridian 23. degrees 8. minutes the length of the Perpendicular, and there I make a ſecond Prick: This prick I bring to the Braſen Meridian, ſo is the firſt Meridian ſeparated from the Braſen Meridian ſo many degrees and minutes as is the length of the Perpendicular C A: Then I ſcrew the Quadrant of Altitude to the Zenith, viz. directly over the Equinoctial, and move it about till the edge of it touch the Prick made in the firſt Meridian: So is the Triangle made on the Globe: And the number of degrees and minutes of the Quadrant of Altitude comprehended between the firſt Meridian and the Zenith is the meaſure of the Hypothenuſa C B; which in this Example is 80. degrees 8. minutes: The number of degrees in the Horizon comprehended



headed between the Equinoctial and the Quadrant of Altitude is the meaſure of the Angle C, 85 degrees 44. minutes: the Angle A is a Right Angle, 90. degrees: And to find the Angle B turn the Triangle, (all but the Letters;) Thus as before A C was Baſe, ſo now I make B A Baſe; and as before A B was Perpendicular, ſo now C A ſhall be Perpendicular: ſo is your Triangle turned.

Now, as before I counted 79. degrees 15. minutes from the Equinoctial on the firſt Meridian, which was the length of that Baſe, ſo now I count 23. degrees 8. minutes on the firſt Meridian which is the length of this Baſe, and there (as before) I make a prick, and as before I counted 23 degrees 8 minutes on the Equinoctial from the firſt Meridian, which was the length of that Perpendicular; ſo now I count 79 deg. 15 min on the Equinoctial, which is the length of this Perpendicular; and there I make a prick on the Equinoctial: Then I bring this prick (as before) to the brazen Meridian, ſo ſhall the firſt Meridian be diſtant (as before) from the brazen Meridian ſo many deg. and min. as is the length of this Perpendicular, viz. 79. 15. Then having the Quadrant of Altitude ſcrewed to the Zenith, I turn it about till the edge of it touch the prick made in the firſt Meridian at 23 8. diſtant from the Equinoctial; ſo is the Triangle Turned: And ſo ſhall the arch of the Horizon comprehended between the Equinoctial and the Quadrant of Altitude be the meaſure of the angle B C. 23.30. you alſo ſee the meaſure of the Hypothenuſa B 80. 8. on the Quadrant of Altitude, counted between the Zenith and the firſt Meridian.

PROB. II.

A Leg *and the* Hypothenuſa *given, to find the Reſt.*

Example. The Leg given ſhall be C A in the former Triangle 23. degrees 8 minutes, The Hypothenuſa C B 80. degrees 8. minutes. The Equinoctial and Quadrant of Altitude Rectified, as by the laſt Probleme;

Number

Number the Leg C A 23. degrees 8. minutes on the Equinoctial from the firſt Meridian, and there make a prick; Bring this Prick to the Braſen Meridian; Then number on the Quadrant of Altitude the Hypothenuſa B C 80. degrees 8. minutes from the Zenith towards the Horizon, and make there on the edge of the Quadrant of Altitude another prick: Then turn the Quadrant of Altitude about till the prick made on the edge of it touch the firſt Meridian, ſo ſhall the Triangle be made: The arch of the Equinoctial comprehended between the firſt Meridian and the Braſen Meridian ſhall repreſent A C the Perpendicular; the arch of the Quadrant of Altitude comprehended between the Zenith and the firſt Meridian, ſhall repreſent B C the Hypothenuſa; and the arch of the firſt Meridian comprehended between the Equinoctial and the Quadrant of Altitude ſhall repreſent B A the Baſe, which was one Leg ſought, and is (as you will find) 79 degrees 15 minutes: The Angle C you will find in the Horizon 85 degrees 44. minutes: The Angle A is the Right Angle 90 degrees: And to find the Angle B you muſt turn the Triangle, as you were directed in the former Probleme.

PROB. III.

The Hypothenuſa *and an* Angle *given, to find the Reſt.*

THe Hypothenuſa given ſhall be B C of the Triangle in Prob. 1. 80. degrees 8. minutes, The Angle given ſhall be C, 85 degrees 44. minutes: The Globe and Quadrant of Altitude Rectified, as by Prob. 1. count the given Angle 85. degrees 44. minutes on the Horizon from the Equinoctial, and there place the Quadrant of Altitude: Then turn about the Globe till the firſt Meridian touch 80. degrees 8. minutes of the Quadrant of Altitude counted from the Zenith downwards, ſo ſhall the Triangle be made on the Globe: The Arch of the Equator comprehended between the firſt Meridian and the Braſen Meridian ſhall ſhew the length of the Perpendicular C A 23. degrees 8. minutes; the Arch of the firſt Meridian comprehended between the Equinoctial and the Quadrant of Altitude ſhall ſhew the length of the Baſe A B 79. degrees 15. minutes; the Right Angle made at the Interſection of the Braſen Meridian at the Equinoctial is 90. degrees: and to find the meaſure of the Angle B you muſt turn the Triangle, as you were directed Prob. 1.

PROB. IIII.

A Leg *and* Angle *adjoyning given, to find the Reſt.*

IN the Triangle of Prob 1. The Leg given ſhall be C A 23. degrees 8. minutes, the Angle adjoyning ſhall be C 85. degrees 44. minutes: The Globe and Quadrant of Altitude Rectified as by Prob. 1. I turn about the Globe till the firſt Meridian be diſtant from the Braſen Meridian 23. degrees 8. minutes, the length of the Leg C A: Then I count in the Horizon from the Equinoctial 85 degrees 44. minutes, the meaſure of the Angle C; ſo is the Triangle made on the Globe. The Arch of the firſt Meridian comprehended between the Quadrant of Altitude and the Equinoctial ſhall ſhew the length of the Baſe A B 79. degrees 15. minutes; The Arch of the Quadrant of Altitude comprehended between the Zenith and the firſt Meridian ſhall ſhew the length of the Hypothenuſa C B 80. degrees 8. minutes; The Right Angle made at the Interſection of the Equinoctial and the Braſen Meridian is 90 degrees: And to find the meaſure of the Angle B you muſt turn the Triangle, as you were directed Prob. 1.

PROB. V.

A Leg *and the* Angle *oppoſite given, to find the Reſt.*

IN the Triangle of Prob. 1. the Leg given ſhall be A B 79 degrees 15. minutes, the Angle oppoſite ſhall be C 85. degrees 44. minutes. The Globe and Quadrant of Altitude Rectified, as by Prob. 1. I bring the Quadrant of Altitude to 85 degrees 15. minutes of the Horizon, the meaſure of the Angle C: Then I turn the Globe till 79. degrees 15. minutes of the firſt Meridian (which is the meaſure of the Leg A B) touch the Quadrant of Altitude, ſo is the Triangle made on the Globe. The Arch of the Equinoctial comprehended between the firſt Meridan and the Braſen Meridian ſhews the length of the Leg C A 23. degrees 8 minutes; the Arch of the Quadrant of Altitude comprehended between the Zenith and the firſt Meridian, ſhall ſhew the length of the Hypothenuſa C B 80. degrees 8. minutes: The Right Angle made at the Interſection of the Equinoctial and the Braſen Meridian is 90. degrees: And to find the meaſure of the Angle B, you muſt turn the Triangle, as you were directed in Prob. 1.

PROB.

PROB. VI.

The Angles *given to find the* Sides.

IN this Caſe you muſt turn the Angles into Sides, making an Oblique Triangle on the Globe, whoſe Sides ſhall be equal to the given Angles: ſo ſhall the Angles of this Triangle found, be the meaſure of the Sides required.

Example.

In the Triangle of Prob. 1. The Angle A is 90. degrees, the Angle B 23. degrees 30. minutes, the Angle C 85 degrees. 44. minutes: The Globe and Quadrant of Altitude Rectified as by Prob. 1. I ſet the Right Angle A 90. degrees on the Braſen Meridian between the Pole and the Equinoctial; For the Angle B, I number downwards on the Quadrant of Altitude 23. degrees 30. minutes which ſhall be the ſide repreſenting that Angle: for the Angle C I number on the firſt Meridian from the Pole towards the Equinoctial 85 degrees 44. minutes, which ſhall be the ſide repreſenting that Angle: Then I turn the Globe and Quadrant of Altitude till I can joyn the 23. degrees 30. minutes counted before on the Quadrant of Altitude and this 85. degrees 44. minutes counted in the firſt Meridian together; So is a Triangle made on the Globe; whoſe ſides being equal to the angles given, ſhall have its angles equal to the ſides required: Thus the arch of the Equinoctial contained between the firſt Meridian and the brazen Meridian ſhall be found 23. 8. the meaſure of the ſide A C: the arch of the Horizon between the neereſt Pole and the Quadrant of Altitude ſhall be found 79 15. the meaſure of the ſide B A: And to find the Hypothenuſa B C, you have now *Data's* enough, either to find it as by ſome of the former Problemes; or elſe you may find it by turning the Triangle, as by Prob. 1.

Theſe Caſes of Right Angled Spherical Triangles may be wrought otherwais by the Globe, if you alter its poſition, making the North or South points of the Horizon Zenith; or elſe the Poles of the World, or the Poles of the Ecliptick; and uſe the Circle of Poſition inſteed of the firſt Meridian or circles of Longitude. But theſe inſtructions together with a little practice are (I judge) ſufficient: Therefore I ſhall refer Varieties to the ſtudies of the induſtrious Studient.

Of Oblique Triangles.

PROB. VII.

The three Sides given, to find the Angles.

ELevate the Pole of the Globe above the Horizon to the complement of one of the given sides, and screw the Quadrant of Altitude in the Zenith, so shall that given side be comprehended between the Pole and the Quadrant of Altitude; Then count from the Pole upon the first Meridian the measure of the second side, and there make a prick: Count also from the Zenith upon the Quadrant of Altitude downwards the measure of the third side, and make there on the edge of the Quadrant of Altitude another prick; Then turn the Globe and Quadrant of Altitude till you can joyn these two pricks together, so shall your Triangle be made on the Globe: And then the number of degrees of the Equinoctial comprehended between the first Meridian and the brazen Meridian shall be the measure of the angle at the Pole: The arch of the Horizon contained between the Quadrant of Altitude and the intersection of the brazen Meridian with the Horizon on the side the Pole is elevated shall be the measure of the second angle. For finding the third, Turn the Triangle, as by Prob. 1.

Example.

In the Triangle A B C annexed, The side A B contains 38 degrees 30 minutes, the side B C 25 degrees, and the side A C 60 degrees; I would measure these Angles; I place one of these sides upon the Meridian, viz. A B 38. 30 The Complement of 38.30 is 51 deg.30 m. Therefore I elevate the Pole 51. 30. above the Horizon, so shall the Zenith be distant from the Pole 38. 30. here I screw the Quadrant of Altitude and count downwards on it the measure of the side B C 25 deg. and there I make a prick: then from the Pole I count

I count on the firſt Meridian 60 deg. the meaſure of the ſide A C, and there I make another prick: Then I turn the Globe and Quadrant of Altitude backwards or forwards till theſe two pricks are joyned together; ſo ſhall the Triangle A B C be made on the Globe: The arch of the brazen Meridian comprehended between the Pole and Zenith ſhall repreſent the ſide A B; the arch of the Quadrant of Altitude comprehended between the firſt Meridian and the brazen Meridian ſhall repreſent the ſide B C; and the arch of the firſt Meridian comprehended between the Pole and the Quadrant of Altitude ſhall repreſent the ſide A C; The Pole ſhall repreſent the angle A, the Zenith the angle B, and the interſection of the firſt Meridian with the Quadrant of Altitude ſhall repreſent the angle C. The angle at the Pole is meaſured in the Equator; for the degrees comprehended between the firſt Meridian and the brazen Meridian being 17 deg. 15 min. ſhews 17 degrees 15 min. to be the meaſure of the angle A: The angle at the Zenith is meaſured in the Horizon; for the degrees comprehended between the Interſection of the Braſen Meridian with the Horizon on that ſide the Pole is Elevated being 142. degrees 42. minutes, ſhews that 142. degrees 42. minutes is the meaſure of the Angle B. Thus two Angles are found; the third is wanting: which I find thus:

I turn the Triangle, placing either A or C in the Zenith. Example. I place A at the Zenith, which before was at the Pole; ſo ſhall C be at the Pole, and B at the Interſection of the firſt Meridian and the Quadrant of Altitude, and the ſide A C ſhall be comprehended between the Pole and Zenith: The ſide A C contains 60. degrees; its Complement to 90. is 30. degrees; therefore I Elevate the Pole of the Globe 30. degrees above the Horizon; ſo ſhall 60 degrees be in the Zenith; therefore to 60. degrees I ſcrew the Quadrant of Altitude and count on it downwards the meaſure of the other ſide next the Zenith, viz. 38 degrees 30. minutes; and there I make a prick: Then from the Pole on the firſt Meridian I count the meaſure of the laſt ſide viz. 25. degrees, and there I make another prick: Then I turn the Globe and Quadrant of Altitude (as before) till theſe two pricks joyn; ſo is the Triangle altered on the Globe: For the Arch of the Braſen Meridian comprehended between the Pole and Zenith which before was 38. degrees 30. minutes is now 60. degrees, the Arch of the Quadrant of Altitude comprehended between

tween the firſt Meridian and the Braſen Meridian, which before was 25. degrees, is now 38. degrees 30. minutes and the Arch of the firſt Meridian comprehended between the Quadrant of Altitude and the Pole, which before was 60 degrees is now 25. degrees. Thus the Angle C being now at the Pole, its meaſure is found in the Equinoctial, viz. the Arch comprehended between the firſt Meridian and the Braſen Meridian which is 25. degrees 24. minutes; and the meaſure of the Angle A which is now in the Zenith: having its ſides the one an Arch of the Braſen Meridian, the other an Azimuth, (or which is all one) an Arch of the Quadrant of Altitude, is meaſured in the Horizon, as all Azimuths are, and found 17. degrees 15. minutes, as before.

PROB. VIII.

Two Sides *and the* Angle *contained between them given, to find the Reſt.*

EXample, In the former Triangle I have given the ſides A B, 38 deg. 30 min. A C, 60 deg. and the Angle A 17 deg. 15 min.

I Elevate the Pole of the Globe to the Complement of one of the given ſides; ſuppoſe the ſide A B, which being 38 deg. 30 min. its complement to 90 deg. is 51 deg. 30 min. ſo ſhall the Zenith be diſtant from the Pole 38 deg. 30 min. the meaſure of the ſide AB: The other ſide is 60 deg. this 60 deg. I count from the Pole in the firſt Meridian, and there I make a prick: The angle given is 17 deg. 15 min. this I count in the Equinoctial from the firſt Meridian, and this degree and minute in the Equinoctial I bring to the brazen Meridian, ſo ſhall the firſt Meridian be ſeparated from the brazen Meridian 17 deg. 15 min. Then I ſcrew the Quadrant of Altitude to the Zenith, and bring the ſide of it to the prick made in the firſt Meridian: ſo ſhall the Triangle be made on the Globe. Then to find the unknown ſide B C, I count the number of degr. on the Quadrant of Altitude contained between the Zenith and the firſt Meridian, and find 25. which is the meaſure of the ſide BC: To find the meaſure of the angle B, I count the number of degrees contained between the interſection of the Meridian with the Horizon on that ſide the Pole is elevated and the Quadrant of Altitude, and find 142 deg. 42 min. which is the meaſure of the angle B: And to find the angle C, I turn the Triangle, as in

PROB. IX.

Two Sides *and an* Angle *oppoſite to one of them given, to find the Reſt.*

EXample. In the Triangle in Prob. 7. the Sides given are A B 38. degrees 30. minutes, and A C 60 degrees: The Angle given oppoſite to A C is B 142. degrees 42. minutes: I elevate the Pole to the Complement of one of the given ſides; ſuppoſe A B, which being 38 degrees 30. minutes, its Complement to 90. degrees is 51. degrees 30 minutes; ſo is the Zenith diſtant from the Pole 38. degrees 30. minutes: To this 38. degrees 30. minutes I ſcrew the Quadrant of Altitude, and count in the Horizon from the Interſection of the Meridian with the Horizon on that ſide the Pole is Elevated the meaſure of the given Angle B, viz. 142. degrees 42. minutes, and to this number of degrees and minutes of the Horizon I bring the edge of the Quadrant of Altitude, then I count in the firſt Meridian from the Pole the meaſure of the ſide A C 60. degrees; and there I make a prick and turn about the Globe till that prick come to the edge of the Quadrant of Altitude, ſo is the Triangle made on the Globe: the degrees of the Quadrant of Altitude comprehended between the firſt Meridian and the Zenith being 25. degrees, is the meaſure of the ſide B C: The degrees of the Equinoctial comprehended between the firſt Meridian and the Braſen Meridian being 17. degrees 15. minutes, is the meaſure of the Angle A; and for finding the meaſure of the Angle C, I turn the Triangle, as in Prob. 7.

PROB. X.

Two Angles *and the* Side *comprehended between them given, to find the Reſt.*

EXample, In the Triangle of Prob. 7. the Angles given are A 17. degrees 15. minutes, and B 142 degrees. 42. minutes, the ſide comprehended between them is A B 38. degrees 30. minutes; I elevate the Pole to the complement of the ſide A B, which being 38 degrees 30 minutes, its complement to 90 de-

grees is 51 degrees 30 minutes ſo is the Zenith diſtant from the Pole 38 degrees 30 minutes; to this 38 degrees 30 minutes I ſcrew the Quadrant of Altitude, and count in the Horizon from the Interſection of the Meridian with the Horizon on that ſide the Pole is Elevated the meaſure of the given Angle B, viz. 142 degrees 42 minutes, and to this number of degrees and minutes of the Horizon I bring the edge of the Quadrant of Altitude; then I turn about the Globe till the firſt Meridian is diſtant from the Braſen Meridian 17 degrees 15 minutes of the Equinoctial which is the meaſure of the other given Angle; So ſhall the Triangle be made on the Globe: and the arch of the Quadrant of Altitude comprehended between the firſt Meridian and the Zenith ſhall be the meaſure of the ſide B C 25. degrees, and the Arch of the firſt Meridian comprehended between the Pole and its Interſection with the Quadrant of Altitude ſhall be the meaſure of the ſide A C 60. degrees. The meaſure of the Angle C is found by turning the Triangle, as in Prob. 7.

PROB. XI.

Two Angles *and a* Side *oppoſite to one of them given, to find the Reſt.*

EXample. In the Triangle of Prob. 7. the Angles given are A 17. degrees 15. minutes, and B 142. degrees 42. minutes, the ſide given is B C 25. degrees being the ſide oppoſite to the Angle A; the Angle A is made at the Pole of the Globe, and meaſured in the Equator: Therefore I ſeperate the firſt Meridian from the Braſen Meridian 17. degrees 15. minutes, ſo doth the Pole repreſent the Angle A; the Angle B is made at the Zenith, and meaſured in the Horizon; therefore I count in the Horizon 142. degrees 42. minutes, and there I make a prick, to this prick I bring the edge of the lower end of the Quadrant of Altitude, (not minding to what degrees of the Meridian the upper end of it is placed) Then I count from the upper end of the Quadrant of Altitude 25. degrees downwards, the meaſure of the ſide B C, and there I make a prick, and keeping the lower end of the Quadrant of Altitude to the prick made in the Horizon, I ſlide the upper end of it forwards or backwards till the prick on the Quadrant of Altitude come to the firſt Meridian, ſo ſhall the Triangle be made

on

on the Globe: Then the Arch of the Braſen Meridian comprehended between the Pole and the upper end of the Quadrant of Altitude ſhall be the meaſure of the ſide A B 38. degrees 30. minutes; and the Arch of the firſt Meridian comprehended between the prick on the Quadrant of Altitude and the Pole ſhall be the meaſure of the ſide A C 60 degrees; But the Angle C you muſt find by turning the Triangle; as in Prob. 7.

In the working this Probleme I would have placed the given ſide B C 25 degrees upon the Braſen Meridian between the Pole and Zenith; but then the Angle B (being ſo Obtuſe) would have had that ſide which would be interſected by the Quadrant of Altitude viz. the firſt Meridian) under the Horizon, which the Quadrant of Altitude cannot reach.

PROB. XII.

Three Angles *given, to find the* Sides.

THis Triangle is taught to be reſolved by Mr *Palmer* on the *Planiſphear*; Book 3 Chap. 19.

It is to be known (ſaith he) That if you go to the Poles of the three great Circles whereof your Triangle is made, theſe Poles ſhall be the Angular points of a ſecond Triangle; and the two leſſer ſides of this ſecond Triangle ſhall be equal to the two leſſer Angles of your firſt Triangle: the greateſt ſide of the ſecond Triangle ſhall be the ſupplement of the greateſt Angle of the firſt Triangle (that is, ſhall have as many degrees and minutes as the greateſt Angle of the firſt Triangle wanted of 180. degrees (ſee *Piriſcus. Trigonometry Lib.* 1. *Prob.* 61.

This ſecond Triangle therefore (all whoſe ſides are known from the Angles of the firſt) you ſhall reſolve by Prob. 7. And having by that Probleme found the Angles of the ſecond Triangle, know that the two leſſer Angles of the ſecond Triangle ſhall be ſeveral and reſpectively equal to the two leſſer ſides of the firſt Triangle, (and the leaſt Angle to the leaſt ſide, the middle Angle to the middle ſide) and the greateſt Angle of this ſecond Triangle being ſubſtracted out of 180. degrees ſhall leave you the greateſt ſide of your firſt Triangle.

Example. If the Angles be given 142. degrees 42. minutes, 17 degrees 15 minutes and 25, degrees 24 minutes; and the

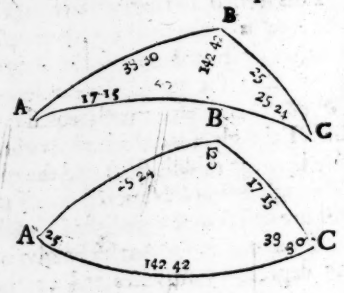
ſides be enquired. Draw by aim a rude Scheam of this firſt Triangle writing in the Angle A 17 degrees 15 minutes, in B 142. degrees 42. minutes, in C 25 degrees 24. minutes; ſuppoſing the ſides yet unknown: then draw under this by aim alſo, a Scheam of the ſecond Triangle, ſetting his Baſe Parallel with the Baſe of the firſt, and making the Baſe of the ſecond ſhorter than the Baſe the firſt. Set alſo B at the Vertical Angle, and A C at the Baſe; as in the firſt Triangle. Then ſay,

Becauſe A in the firſt Triangle is 17. degrees 15. minutes, therefore in the ſecond Triangle B C (which ſubtendeth A) ſhall be 17. degrees 15. minutes: and becauſe C in the firſt Triangle is 25. degrees 24 minutes, therefore in the ſecond Triangle the ſide A B which Subtendeth C ſhall be 25 degrees 24. minutes; and becauſe B the greateſt Angle in the firſt Triangle, is 142. degrees 42. minutes, therefore in the ſecond Triangle the ſide A C (which ſubtendeth B) ſhall be the Complement thereof to 180. degrees, viz. 37. degrees 18. minutes: wiire now upon the ſides of this ſecond Triangle the quantities of the ſides, ſo is your ſecond Triangle ready to be reſolved, as by Prob 7. whereby you ſhall find the Angles of the ſecond Triangle, as I have expreſſed them in the Scheam; A 25 degrees, C 38 degrees 30 minutes, B 120. degrees.

Now laſtly, I ſay theſe Angles of the ſecond Triangle thus found, give me the ſides of the firſt Triangle, which I ſeek, in this manner.

In the ſecond Triangle.	In the firſt Triangle.
A is 25 degrees	B C is 25 degrees.
C is 38. 30	A B 38. 30.
B is 120. 00. Therefore	A C 60. 00. Complement

of 120. degrees to 180. And thus by all the Angles given we have found out all the ſides which was required.



Having then the Angles of your firſt Triangle given, and his ſides now found; you ſhall find his ſcituation on on the Globe thus: Place him as in Prob. 7. A B 38. degrees 30. minutes between

the

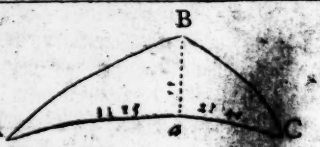
the Pole and Zenith, A C 60. degrees in the firſt Meridian ſeparated from the Braſen Meridian 17. degrees 15. minutes of the Equinoctial, B C 25. degrees on the Quadrant of Altitude counted from the Zenith when its lower end is applyed to 142. degrees 42. minutes of the Horizon: you ſhall ſay, becauſe the Eaſt point of the Horizon is the Pole of the Arch A B, therefore at the Eaſt point of the Horizon ſhall ſtand the Angle C, which A B ſubtendeth: Then number from the Quadrant of Altitude 90 deg. on the Horizon Eaſtwards, and there is the Pole of the Arch B C: Therefore there ſhall ſtand the Angle A, which B C ſubtendeth. Theſe 90 deg. will end at 37 deg. 18 min. counted from the Eaſt point of the Horizon Northwards: then count in the Equator from the firſt Meridian 90 deg. which will end under the Horizon, and there make a prick; for there is the Pole of the Arch or ſide A C. Therefore at that prick ſhall ſtand the Angle B which A C ſubtendeth.

Here you ſee your ſecond Triangle made by the Poles of the firſt adjoyning to the Eaſt point of the Globe; only the ſide A B is wanting: To get that, make a prick upon the Globe againſt the 37 deg. 18 min. from the Eaſt point of the Horizon Northwards found before, to repreſent the Angle A: Then turn about the Globe and Quadrant of Altitude till that prick and the prick made before for the Angle B are both at once cut by the ſide of the Quadrant of Altitude, and you will find 25. deg. 24. min. of the Quadrant of Altitude comprehended between the two pricks, for the meaſure of the ſide A B.

PROB. XIII.

How to let fall a Perpendicular *that ſhall divide any* Oblique Spherical Triangle *into two* Right Angled Spherical Triangles.

THis Probleme is much uſed when an Oblique Triangle having two ſides and an Angle given is to be ſolved by the Cannon of *Sines* and *Tangents*: but by the Globe it may be ſolved without it, as was ſhewed Prob. 8, 9. Yet becauſe letting fall a Perpendicular is ſo frequent in all Authours that treat of *Trigonometry*, I have inſerted this Probleme alſo.



In the Oblique Triangle of the former Problemes there is given the ſides A B 38 ¼ degrees, and B C 25 degrees and the Angle C 25. degrees 24. minutes; It is required to let fall a Perpendicular as B *a* from the Angle B, upon the Baſe A C; and to know both the meaſure of this Perpendicular, and the parts it divides the Baſe into.

Therefore Elevate the Pole of the Globe above the Horizon ſo much as is the meaſure of the Angle C, which in this Example is 25. degrees 24. minutes, and bring the interſection of the firſt Meridian with the Equinoctial to the Eaſt point in the Horizon; ſo ſhall the Angle at the Eaſt point of the Horizon comprehended between the Horizon and the firſt Meridian be equal to the Angle C: then count in the firſt Meridian from the Eaſt point of the Horizon the meaſure of the ſide B C 25. degrees, and having the Quadrant of Altitude ſcrewed to the Zenith, bring the graduated edge of it to theſe 25. degrees, ſo ſhall the Arch of the Horizon comprehended between the Eaſt point and the lower end of the Quadrant of Altitude be the number of degrees that the Perpendicular falls upon the Baſe, counted from the Angle C to *a* which in this Example is 21 ¾ degrees, and the Arch of the Quadrant of Altitude comprehended between the Horizon and the firſt Meridian is the meaſure of the Perpendicular B *a* 11. degrees.

And thus by letting fall this Perpendicular you have two Right angled Spherical Triangles made, the one B *a* C, wherein is found C *a* 21 ¾ degrees, B C 25. degrees B *a* 11. degrees, C 25. degrees 24 minutes, and *a* the Right Angle: There remains only the angle B unknown; which you muſt find by turning the Triangle, as was taught Prob. 1. The other Right angled Spherical Triangle made, is B *a* A, wherein is found A *a* (Complement of 21 ¾ degrees to 60. degrees (the whole Baſe before given) 38 ¼ degrees, A B 38 degrees 30. minutes, B *a* 11. degrees, and *a* the Right Angle; which is more than enough to find the Angles A and B; as was ſhewed in the *Preface. Theorem* 1.

The End of the Sixth Book.

An

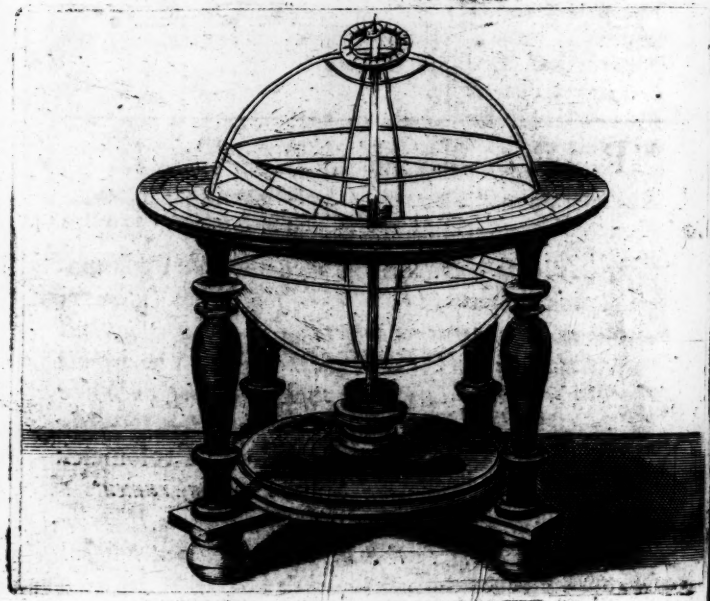
An *APPENDIX*, Shew[illegible] the EXPLANATION and USE of the PTOLOMAICK SPHERE.

PRÆFACE.

HAving for ſome time paſt made and ſold Ptolomaick Spheres, *I have found ſome of my Cuſtomers much deſirous of ſomething that might inſtruct them in the* Uſe *of it: And to comply with their deſires I have publiſht this* Appendix; *which though it be ſmal, yet conſidering what hath been taught of the Uſe of the* Globes, *it is copious enough for the Vſe of the* Ptolomaick Sphere: *For the* Globe *and* Sphere *are Inſtruments of ſo neer a Kin, that Readers of Aſtronomie many times indifferently name either the one or the other for the ſame purpoſe.*

There hath indeed a Book been publiſht of the Vſe of the Ptolomaick Sphere; *but the Sphere that Book was made for differs from the Spheres Vulgarly made: for that Sphere was purpoſely made for Prince* Henry, *eldeſt Son to King*

King James *of blessed memory, and no cost spared to make it either Vsefull or Beautifull: as may yet be seen by the Instrument it self, it being now in the possession of* Jonas More *Esq. in the Tower of* London, *and therefore would be too deer for general sale. But the* Spheres *for which this* Appendix *is designed is the Common* Ptolomaick Sphere, *by which Sphere after a Practitioner grows a little familiar with the constitution of the Heavens he may sufficiently conceive how the Zodiacal and Eliptical motions of the Planets are made: and also in what places of their several Orbs their Perigeums and Apogeums will fall out.*



What a Sphear is.

I Told you in the firſt Chapter of the firſt Book, that a Globe according to the Mathematical definiton is a perfect and exact round Body contained under one ſurface. The definition of a Sphear is the ſame. So then, the Globe and Sphear as they are Geometrick Bodies are alſo the ſame. Yet, as they are Aſtronomical Inſtruments there is difference in them: For as a Sphear is an Aſtronomical Inſtrument It is a complication of material Circles only, ſo fitted together that they repreſent all the imaginary Circles and motions of the eighth Sphear, and the Circles and motions of all the Planets about the Earth. Therefore on this material Sphear you can neither have all the Conſtellations and Stars, nor the ſhape of the Earth, Waters, Towns, &c. depicted: becauſe of the vacuities between the ſeveral circles. Yet is the Sphear applycable to almoſt all the Aſtronomical uſes the Celeſtial and Terreſtrial Globes are: And in ſome caſes more apt to repreſent the Order and Appearence of the Planetary Orbs. For thereon have you repreſented the Zodiack, the Equinoctial, the Colures, the Tropicks, the Polar Circles, the Meridian, the Horizon, Vertical Circle, Hour Circle, &c. juſt in the ſame manner and order they are on the Celeſtial and Terreſtrial Globe; and therefore I refer you to their ſeveral Definitions in the firſt Book: Only with this difference, that where you find *Globe* you read *Sphear*.

And as the Circles of the Globe and Sphear are the ſame, ſo is the manner of working with the Globe and Sphear the ſame; and the precepts you find in the ſeveral Problemes throughout this Book that relate only to the Circles you find in the Sphear, ſerve indifferently and in the ſame manner for the Sphear, if (as was ſaid) you only read *Sphear* where you find *Globe*. This I ſhall paſs by without farther inlarging on, becauſe it is ſo plain: and ſhall come to ſhew you in what reſpect a Sphear is more apt to repreſent the Order and Appearence of the Planetary Orbs than a Globe is. And that is becauſe a Sphear is complycated only of Lath-like Circles to repreſent each Orb, and is not an intire Orb as a Globe is, ſo that you may ſee the ſeveral Fabrications that are made within it. But if the Sphear were made of intire Orbs you could ſee only the outmoſt Orb, not any of the inner Fabri-

cations: as we may ſee in an Onyon, which though it be made up of ſeveral Orbs the one within another, as the whole World is of many Heavens or Orbs one within another, yet can we only ſee the outmoſt Orb or ſcale of the Onyon, that wrapping up and hiding all the other from our Eys. So that all the Orbs (as we muſt call them of the Sphear) are not real Orbs, but ſerve only for the repreſentation of Orbs.

Beſides, you have every Planet repreſented in an Orb by it ſelf, and that in the ſame order that it is ranked in in Heaven.

As firſt, the outmoſt Orb of all, which repreſents the Orb of the eighth Heaven, or Starry Heaven, conſiſts of the two Colures, which are thoſe two great Circles that croſs each other at right angles in the Poles of the World, and are divided from the Equinoctial each way into 90 degrees, and numbred with numerical figures from the Equinoctial towards either Pole with 10, 20, 30, to 90.

Secondly, The Equinoctial, which is a circle lies exactly in the middle between the two Poles, and cuts the Colures at right angles, as it is alſo cut by them. It is divided into 360 degrees, numbred from the Vernal Colure Eaſtwards, with 10, 20, 30, to 360.

Thirdly, The Zodiack, which is a broad Circle that lies obliique or aſlope from the Equinoctial, making an angle of $23\frac{1}{2}$ degrees with it. It is cut by the Equinoctial and its Colures in two points, viz in ♈ and ♎, and by the Tropical Colure in two points, viz. in ♋ and ♑. In the middle of this broad Circle lies the Ecliptick line, which is divided into twelve equal parts, called *Signes*, as *Aries*, *Taurus*, *Gemini*, &c. to *Piſces*, and ornamented with the picture of each Signe, as to ♈ you have the picture of a Ram, to ♉ a Bull, and ſo of the reſt. Each Sign is again divided into 30 degrees, and numbred from the beginning of the Signe towards the end with 10, 20, to 30. It hath about 5 degrees of bredth on either ſide the Ecliptick, for the ſwerving of the Planets from the true Ecliptick line.

Fourthly, The two Tropicks are ſmaller Circles commonly made of Wyer, that decline $23\frac{1}{2}$ degrees from either ſide the Equinoctial, and therefore bound the Ecliptick. They cut the Colures at right angles, as alſo they are cut by the Colures.

Fifthly, The Arctick and Antarctick Circles, are two Circles yet ſmaller than the Tropicks, alſo made of Wyer, that decline $23\frac{1}{2}$ de-

23½ degrees from either Pole: These also cut the Colures at right angles, as they are also cut by the Colures.

This Machine is called the eighth Heaven, because it serves to represent the eighth Heaven: But its motion is performed upon its two Poles, through which runs a straight Wyer, to represent the Axis of the World, and therefore is called the Axis: Next within the eighth Heaven, is placed the Sphere or Heaven of *Saturn*. It is represented by three Circles: Two of them cut each other at right angles in their Poles, even as the Colures do. But for distinction from the Colures shall be called Upright Circles when ever I name them with relation to the Sphere of any of the Planets: The other Circle cuts these upright Circles, and is also cut by them at right angles in the middle between their two Poles: as the Equinoctial does the Colures; which Circle I shall hereafter call the Flat Circle, when I name it with relation to the Sphere of any of the Planets: on this Circle is writ *Sphera Saturni*: and hard by it is fitted on one of the Upright Circles, a Brass plate with a button on it, which button represents the Star or Planet ♄ it self: it is made to slide Northwards or Southwards on the Upright Circle, because ♄ oft alters its Latitude from the Ecliptick, and consequently its Declination: And by this means you may slide it to any Latitude, or Declination you shall see cause for.

Next within the Sphere of Saturn, is placed the Sphere of Jupiter, which is represented by such Circles, and a sliding Button, even as the Sphere of Saturn is.

Next within the Sphere of ♃, is placed the Sphere of ♂, within the Sphere of ♂, the Sphere of ☉, within the Sphere of ☉, the Sphere of ♀, within the Sphere of ♀, the Sphere of ☿, within the Sphere of ☿, the Sphere of ☾, all represented as is the Sphere of ♄, and all performing their motions upon their own Poles, and the Axis of the World.

Within the Sphere of ☾, is placed a smal Globe of the Earth, whereon is described all the Countries of the Earth, and the names of so many inserted as the magnitude of that Globe is conveniently able to receive.

This Ball is fixed in the middle of all the Heavens, and about it, as about a common Center, they all perform their various motions.

This Machine, or Fabrick, or Model of the visible World,

(which you will) is hung in a Braſen Meridian, as a Globe is. See 4. of Chap. 1. Book 1. And this Meridian is lett into a wooden Horizon as in § 5. of the ſame Chap. and Book.

The Quadrant of Altitude, Hour Circle, and its Index, Nautical Compaſs, and Semi-Circle of Poſition, which belong to a Sphere, are in all reſpects the ſame with thoſe belonging to a Globe, and therefore I refer you to § 6, 7, 8, 9. of the ſame Chapter.

But becauſe all Problemes that have relation to any of the Planets, or their Spheres are more aptly and properly performed by the Sphere than the Globe, (becauſe you have a particular Heaven, aſſigned each particular Planet, and by reaſon of the openneſs of every Sphere you may ſee the more natural ſcituation and poſition of them all at once.) Therefore I here produce two Problemes which may ſerve as examples to direct you in all operations, that you may meet with of this nature. And firſt,

PROB. I.

To ſet the Sphere *and all the* Planets *in a poſition agreeable to the whole frame of the viſible World, at any given Time.*

FIrſt Rectifie the eighth Sphere, Horizon, Quadrant of Altitude, and Hour Index to your elected Time. Then by an Ephemeris find the true places of the Planets in Heaven for that time: and bring each reſpective Node which repreſents each reſpective Planet, to thoſe ſeveral places you find them in in the Ephemeris; ſo ſhall the Planets appear in the Sphear juſt in the ſame place they are in Heaven.

Example.

I would place the Planets on the Sphere to agree with the Places they have at this preſent Time, viz. 1669. *Sept.* 17. juſt at Noon, in the Latitude of 51½ degrees. Therefore I firſt Rectifie the Sphere to the given Time, as by Prob 2. of the 2d. Book, then in the Ephemeris I find the place of the Sun ♎ 4 degrees 42 minutes, therefore I bring the little golden Node on the Suns Orb

Orb to ♒ 4 degrees 42 minutes, ſo is that little golden Node placed in the Sphere to agree with the place the Sun hath in Heaven: then ſearching the Ephemeris again for the Moons place, I find ſhe is in ♏ 0 degrees 36 minutes, and hath 10 minutes North Latitude from the Ecliptick; Therefore I bring the little ſilvered ☾ in the Moons Orb, to ♏ 0 degrees 36 minutes of the eighth Sphere, and ſlide the ſilver ☾ 10 minutes to the Northwards of the Ecliptick line, ſo is that ſilvered Moon placed in the Sphere ſo as to agree with the place the Moon hath in Heaven. Then ſearching in the Ephemeris for the place of ♄, I find ♄ in 19 degrees 19 minutes of ♒, and hath 1 degree 27 minutes South Latitude from the Ecliptick: therefore I bring the little Node or Ball upon the Sphere of ♄, to ♒ 19 degrees 19 minutes of the eighth Sphere, and ſlide the button or Node which repreſents ♄ 1 degree 27 minutes to the Southwards of the Ecliptick line: ſo is that Node or Ball placed in the Sphere to agree with the place ♄ hath in Heaven. The like way I uſe, to place ♃, ♂, ☿, ♀, in the Sphere to agree with their places in Heaven.

The eighth Sphere and the Nodes repreſenting all the Planets, being thus poſited, becomes an actual repreſentation of the whole frame of the viſible World: and all the Spheres of the Planets by being turned about with the eighth Heaven, perform a Diurnal mutation, and ſhew all the various appearances they will have in Heaven, for that day, viz. The time of their Riſing and Setting, as by Prob. 7, 8. Their Altitudes as by Prob. 6. Their Amplitudes as by Prob 16. Their Azimuths and Almicantars as by Prob. 22, 23. Their Right Aſcentions as by Prob. 26. Their Declinations as by Prob. 2. Their Oblique Aſcenſions and Oblique Deſcenſions as by Prob. 28. Their Diurnal and Nocturnal Arches as by Prob. 38. of the ſecond Book: Their Configurations or Aſpects among themſelves, and their Circulations about the Earth.

PROB. II.

How Eclipſes *are Demonſtrated by the* Sphere.

YOu muſt know that the Moon moves not conſtantly in the Ecliptick, as the Sun does, for if ſhe did, there would two Eclipſes happen every Moneth; the one of the Sun, and the other of the Moon, but ſhe moves in a

Circle oblique to the Ecliptick about 5 deg. even as the Ecliptick is oblique to the Equinoctial 23½ deg. And as the Ecliptick cuts the Equinoctial only in two oppoſite points, viz. in ♈ and ♎; So the Circle of the Moon cuts the Ecliptick only in two oppoſite points, which are called, The *Dragons-Head* (thus characterred ☊) and the *Dragons-Tail* (thus characterred ☋) That Point which interſects the Ecliptick on the Eaſtern ſide, and proceeds Northwards, is called the *Dragons-Head*; and the oppoſite Point, the *Dragons-Tail*. Theſe Points conſtantly ſhift their places, and have a Retrograde motion through the Ecliptick in almoſt 19. Years: And when the Sun and Moon meet in or near either of theſe Points, or oppoſe each other in or near theſe Points, an Eclips happens; If they meet, the Sun is Eclipſed, becauſe the dark ſollid Body of the Moon, interpoſes between our ſight and the Sun, and ſo hides him: If they oppoſe each other, the Moon is Eclipſed, for then the dark ſolid Body of the Earth, interpoſes between the Sun and the Moon, and ſo hinders the light of the Sun from falling upon the Moon, which hath no light of its own but what it receives from the Sun.

But that you may the more plainly ſee the Demonſtration of Eclipſes by the Sphere: Place the Golden Ball repreſenting the Sun, and the Silvered ☾ repreſenting the ☾ in two oppoſite points of the Ecliptick; So ſhall the Sun, the Earth, and the Moon be all in a ſtraight line, and the Moon Eclipſed; becauſe the Earth lying directly between the Sun and the Moon, keeps the light of the Sun off the Moon, and ſo becomes a ſhadow to her, which of her ſelf hath no light but what ſhe receives from the Sun, as was ſaid before; and the Moon will continue darkned, till ſhe come out of the Earths ſhadow.

Again, Place the Sun and Moon in the ſame Signe and degree of the Ecliptick, and imagine as before, a light to come from the Sun in the Sphere; then will you ſee reaſon why the light of the Sun cannot fall upon the Earth, viz. becauſe the Moon is interpoſed betwixt the Sun and the Earth, and ſo ſhadows the Earth by keeping the light of the Sun off it, which to us appears as if the Sun were darkned, though indeed it is only the Earth that is deprived of the Suns light by the interpoſition of the Moon, as aforeſaid.

But becauſe an Eclipſe happens not, as was ſaid before, but when the Sun and Moon ſeems to meet or oppoſe one another in

or

or near the *Dragons-Head* or *Tail*; therefore by the following Rule you muſt learn to find the place of the *Dragons-Head* and *Tail*, that ſo by the Suns and Moons Progreſs through the Ecliptick, you may know when the Sun and ſhe will meet, or oppoſe each other in or near thoſe Points, and accordingly foreknow an Eclipſe.

How to find the place of the Dragons-Head *and* Tail.

The *Dragons-Head* and *Tail* finiſhes a Retrograde Revolution through the Ecliptick in 18 years 224 daies and 3. hours; So that in one year it moves 19 deg. and 20. min. in a Moneth 1. deg. 36. min. and in one day 3. min. Therefore if for any time paſt or to come, you know the Place of the *Dragons-Head* or *Tail* you may add or ſubſtract 19. deg. 20. for every year, 1. deg. 36. min. for every Moneth, and 3. min. for every day, and the Remainder ſhall be the deg. and min. that the *Dragons-Head* or *Tail* is in.

Example.

It is to be ſuppoſed that I remember the Place of the *Dragons-Head* to be in ♍ 12 deg. 20 min. I would know the Place of the *Dragons-Head* for this preſent Day, *Sept.* 17. 1669 Since *January* 1. 1663. there is 6 Years 8 moneths and 17 daies paſt: Therefore for each Year I allow 19 deg. 20 min. which makes 116 deg. for the 8 moneths I allow 8 deg. and 8 times 36 min. viz. 12 deg. 48 min. more, which makes 128 deg. 48 min. and for the 17 daies I allow 5 min. which,

116	00
12	48
	51 added together, make
129 deg.	39 min.

which ſubſtracted (becauſe the *Dragons-Head* moves contrary to the ſucceſſion of Signs) from ♍ 12 deg. 20 min. leaves ♉ 2 deg. 41 min. for the Place of the *Dragons-Head Sept.* 17. 1669. The Place of the *Dragons-Tail*, as was ſaid before, is the Degree and Minute of the Ecliptick oppoſite to that of the *Dragons-Head*, which in this Example is ♏ 2 deg. 41 min.

Here

Here follows the *Ancient* STORIES *of the ſeveral* STARS, *and* CONSTELLATIONS.

Shewing the Poetical Reaſons why ſuch Various Figures are placed in *HEAVEN*.

Collected from Dr HOOD.

And Firſt,

Of the Northern Conſtellations.

URSA MINOR. This Conſtellation hath the preheminence, becauſe it is neereſt of all the reſt unto the North Pole; And is called of the Greeks *Arctos*, whereupon the Pole is called the Pole Arctick, for that it is neer unto that Conſtellation. It is alſo called *Helice minor*, becauſe of the ſmal revolution which it maketh round about the Pole: or rather of *Elice*, a Town in *Arcadia*, wherein *Calliſto* the great Bear, and Mother to the leſs, was bred. It is called *Cynoſura*, becauſe this Conſtellation, though it carry the name of a Bear, yet it hath the tail of a Dog: Laſt of all, it is termed *Phœnice*, becauſe that *Thales*, who firſt gave the name to this Conſtellation, was a *Phœnician*: And therefore the *Phœnicians* being taught how to uſe it in their Navigations, did call it by the name of the Country wherein *Thales* was born. It conſiſteth of 7. ſtars, which the Latines call *Septentriones*; becauſe by their continual motion thoſe ſeven ſtars do as it were wear the Heavens. The *Spaniards* call them all *Boſina*, that is an *Horn*; becauſe they may be very well brought into that form; whereof that which is in the end of the tail, is called the *Pole-ſtar*, by reaſon of the nearenes thereof unto the Pole of the World: for it is diſtant (according to the opinion of moſt) from the true Pole, but 3 deg. 30. min. The Arabians call

call it *Alrukaba*: And of the *Scythyans* it is ſaid to be an *Iron nail*, and is worſhipped by them as a God. The two ſtars that are in the ſholders of the *Bear*, are called the *Guards*, of the Spaniſh word *Guardare*, which is to behold; becauſe they are diligently to be looked unto, in regard of their ſingular uſe which they have in Navigation.

The reaſon why this Conſtellation was brought into the Heavens is diverſly ſet down, and firſt in this manner: Saturn having recevied of the Oracle that one of his Sons ſhould bann ſh him out of his kingdom, determined with himſelf to kill all the men children that he ſhould beget: whereupon he gave command to *Ops* his wife, being then great, that ſhe ſhould ſhew him the child ſo ſoon as ever it was born: But ſhe bringing forth *Jupiter*, and begreatly delighted with his hair, gave the child unto two Nymphs of *Crete*, dwelling in the mount *Dicte*; whereof this was one, and was called *Cynſura*, the other was *Helice*.

Jupiter, after that (according to the Oracle) he had bereft his Father of his Kingdom, in recompence of their paines and courteſie, tranſlated them both into the Heavens, and made of them two Conſtellations; the *Leſſer Bear* and the *Greater Bear*.

Otherſome ſay that it was *Arcas* the ſon of *Caliſto*, and they tell the tale on this manner *Calyſto* a Nymph of ſingular beauty, daughter to *Lycaon* King of *Arcadia*, induced by the great deſire ſhe had of hunting, became a follower of the Goddeſs *Diana*. After this, *Jupiter* being enamored with her Beauty, and out of hope, by reaſon of her profeſſion to win her love in his own perſon conterfeited the ſhape of *Diana*, lay with *Calyſto*, and got her with child, of whom was born a ſon, which was called *Arcas*. *Diana* or rather *Juno*, being very much offended here-with turned *Calyſto* into a *Bear*. *Arcas* her ſon at the Age of fifteen, hunting in the woods by chance lighted upon his mother in the ſhape of a *Bear*: who knowing her ſon *Arcas*, ſtood ſtill that he might come near unto her, and not be afraid: but he fearing the ſhape of ſo cruel a Beaſt, bent his bow of purpoſe to have ſlain her: whereupon *Jupiter* to prevent the miſchief tranſlated them both into Heaven, and of them made two ſeveral Conſtellations: unto the *leſſer Bear*, there belongs but one ſtar unformed.

2. URSA MAIOR, the *Greater Bear*, called alſo of the Greeks *Arctos*, and *Helice*, conſiſteth of 27 ſtars, Among the

which, thoſe ſeven that are in the hinder part and tail of the Bear, are moſt obſerved; the Latines call them *Plauſtrum*; and of our men they are called *Charles Wayn*; becauſe the ſtars do ſtand in ſuch ſort, that the three which are in the tail reſemble the Horſes, and the other four which are in the flank of the *Bear*, ſtand (after a manner) like the Wheels of a Waggon, or Charriot; and they are ſuppoſed by ſome to be greater than the Sun. The reaſon of the Tranſlation of this Conſtellation into the Heaven, is at large ſet down in the other Conſtellation, and therefore needs not here to be repeated. This Conſtellation was firſt invented by *Nauplius*, the Father of *Palamedes* the Greek: and in great uſe among the Grecians; and this is to be noted both in this and the former Conſtellation, that *they never ſet under the Horizon, in any part of Europe*: which though it fall out by reaſon of their ſcituation in the Heavens; yet the Poets ſay, that it came to paſs through the diſpleaſure and hatred of *Juno*; who for that ſhe was by *Caliſto* made a Cuckquean, and they notwithſtanding (as ſhe took it) in diſpight of her, were tranſlated into Heaven, requeſted her brother *Neptune*, that he ſhould never ſuffer thoſe Stars to ſet within his Kingdom. To which requeſt *Neptune* condiſcended; ſo that in all *Europe* they never come neer unto the Sea, or touch the Horizon. If any one marvel, that (ſeeing ſhe hath the form of a *Bear*) ſhe ſhould have a tail ſo long; Imagine that *Jupiter* fearing to come too nigh unto her teeth, laid hold on her tail, and thereby drew her up into Heaven; ſo that ſhe of her ſelf being very weighty, and the diſtance from the Earth to the Heaven very great, there was great likelyhood that her tail muſt ſtretch. The unformed ſtars belonging to this Conſtellation are eight.

3. DRACO, the *Dragon*, of ſome named the *Serpent*; of others the *Snake*, by the *Arabians*, *Aben*; and by *Junctinus Florentinus Vrago*; becauſe he windeth his tail round about the Ecliptick Pole; it containeth 31. ſtars. This was the Dragon that kept the Golden Apples in the Orchard of the Heſperides, (now thought to be the Iſlands of *Cape de Virde*) and for his diligence and watchfulneſs, was afterwards tranſlated into Heaven: Yet others ſay that he came into Heaven by this occaſion; when *Minerva* withſtood the *Gyants* fighting againſt the *Gods*; they to terrifie her, threw at her a mighty *Dragon*; but ſhe catching him in her hands, threw him preſently up into Heaven, and placed him there, as a memorial of that her reſiſtance. Others would

would have it to be the Serpent *Python*, whom *Apollo* ſlew, after the Deluge.

4 CEPHEUS, containeth in him 11. ſtars, and hath two unformed. This was a King of the *Æthiopians*, and Husband unto *Caſſiopeia*, and father of *Andromeda*, whom *Perſeus* married. He was taken up into Heaven, with his wife and daughter, for the good deeds of *Perſeus* his ſon in law; that he and his whole ſtock might be had in remembrance for ever. The Star which is in his right ſhoulder, is called by the *Arabians Alderahiemin*, (*i. e.*) his right Arm.

5. BOOTES, *the driver of the Oxen* (for ſo I ſuppoſe the name to ſignifie, rather then an *Herdſman*; for he hath not his name becauſe he hath the care of any Cattel, but only becauſe he is ſuppoſed to drive *Charles his Wain*, which is drawn by 3 Oxen) he is alſo called *Arctophilax*, the keeper of the *Bear*, as though the care of her were committed to him: This Conſtellation conſiſteth of 22. Stars. Some will have *Bootes* to be *Arcas*, the Son of her who before was turned into the *Great Bear*; and they tell the Tale thus: *Lycaon* the Father of *Caliſto*, receiving *Jupiter* into his houſe as a gueſt, took *Arcas* his daughters ſon, and cut him in pieces; and among other Services, ſet him before *Jupiter* to be eaten: for by this means he thought to prove if his gueſt were a God, as he pretended to be. *Jupiter* perceiving this heinous fact, overthrew the Table, fired the houſe with lightning, and turned *Lycaon* into a wolf: but gathering, and ſetting together again the limbs of the child, he commited him to a Nimph of *Ætolia* to be kept: *Arcas* afterwards coming to mans eſtate, and hunting in the woods, lighted at un-awares upon his mother, transformed by *Juno* into the ſhape of a *Bear*, whom he perſued into the Temple of *Jupiter Lycæus*, whereunto by the law of the *Arcadians*, it was death for any man to come. For as much therefore as they muſt of likelyhood be both ſlain, *Caliſto* by her ſon, and he by the Law; *Jupiter* to avoid this miſcheif, of meer pitty took them both up into Heaven. Unto this Conſtellation belongeth but one ſtar unformed, and it is between the legs of *Bootes*, and by the *Grecians* it is called *Arcturus*, becauſe of all the ſtars neer the great *Bear* named *Arctos*, this ſtar is firſt ſeen neer her tail in the evening. The Poetical invention is thus.

Icarus the Father of *Erigone*, having received of the God

Bacchus a Flagon of wine, to declare how good it was for mortal men, travelled therewith into the Territories of *Athens*, and there began to carouse with certain ſhepheards. they being greatly delighted with the pleaſantneſs of the wine, being a new kind of liquor, began to draw ſo hard at it, that ere they left off, they were paſt one and thirty; and in the end, were fain to lay their heads to reſt. But coming unto themſelves again, and finding their brains ſcarce in good temper, they killed *Icarus*, thinking indeed that he had either poyſoned them, or at the leaſt-wiſe made their brains intoxicate. *Erigone* was ready to die for grief, and ſo was *Mera*, her little dog. But *Jupiter* to allay their grief, placed her father in Heaven, between the legs of *Arctophilax*.

6. CORONA BOREA, the *Northern garland*, conſiſteth of eight ſtars; yet *Ovid* ſaith, that it hath nine. This was the Garland that *Venus* gave unto *Ariadne*, when ſhe was married unto *Bacchus*, in the Iſle *Naxus*, after that *Theſeus* had forſaken her: which Garland, *Bacchus* placed in the Heaven; as a token of his love. *Novidius* will have it to be the *Crown of the Virgin Mary*.

7. ENGONASIS: This Conſtellation hath the name, becauſe it is expreſſed under the ſhape of a man kneeling upon the one knee, and is therefore by the Latines called *Ingeniculum*. It containeth 29 ſtars, and wanteth a proper name, becauſe of the great diverſity of opinions concerning the ſame. For ſome will have it to be *Hercules*, that mighty Conquerer, who for his 12. labours was thought worthy to be placed in the Heaven, and nigh unto the *Dragon* whom he overcame. Others tell the tale thus: That when the *Tytans* fought againſt the *Gods*, they for fear of the *Gyants*, ran all unto the one ſide of the Heaven: whereupon the Heaven was ready to have fallen, had not *Hercules* together with *Atlas* ſet his neck unto it, and ſtayed the fall: and for his deſert, he was placed in the Heaven.

8. LYRA, the *Harp*, it containeth 10. ſtars; whereof thus goeth the Fable. The River *Nilus* ſwelling above his banks, overflowed the Country of *Egypt*; after the fall whereof there were left in the fields divers kinds of living things, and amongſt the reſt a *Tortoiſe*; *Mercury*, after the fleſh thereof was conſumed, the ſinews ſtill remaining, found the ſame, and ſtriking it, he made it yeild a certain ſound; whereupon he made an *Harp* like unto it, having 3. ſtrings and gave it unto *Orpheus* the ſon of *Caſſiopea*.

This

This *Harp* was of ſuch excellent ſourd, that Trees, Stones, Fowls and wild Beaſts are ſaid to follow the ſound thereof. After ſuch time therefore that *Orpheus* was ſlain by the women of *Thrace*, the Muſes by the good leave of *Jupiter*, and at the requeſt of *Apollo*, placed this *Harp* in Heaven. *Novidius* will have it to be the *Harp* of *David*, whereby he pacified the evil ſpirit of *Saul*. This Conſtellation was afterwards called *Vultur Cadens*, the *falling Grype*: and *Falco* the *Falcon*; or *Timpanum* the *Timbrel*.

9. OLOR, or *Cygnus* the *Swan* called of the Caldæans *Adigege* it hath 17 ſtars: of this Conſtellation the Poets Fable in this manner. *Jupiter* being overtaken with the love of *Læda* the wife of *Tyndarus* King of *Oebalia*, and knowing no honeſter way to accompliſh his deſire, procured *Venus* to turn her ſelf into an *Eagle*, and himſelf he turned into the ſhape of a *Swan* Flying therefore from the *Eagle*, as from his natural enemy, that earneſtly perſued him, he lighted of purpoſe in the Lap of *Leda*, and, as it were, for his more ſafety, crept into her boſome. The woman not knowing who it was under that ſhape, but holding (as ſhe thought) the *Swan* faſt in her armes, fell a ſleep: In the mean while *Jupiter* enjoyed his pleaſure; and having obtained that he came for, betook him again unto his wings; and in memorial of his purpoſe (attained under that form) he paced the *Swan* among the ſtars.

Ovid calleth this Conſtellation *Milvius*, the *Kite*, and telleth the tale thus. The Earth being greatly offended with *Jupiter*, becauſe he had driven *Saturn* his father out of his Kingdome, brought forth a monſtrous *Bull*, which in his hinder parts was like a Serpent; and was afterwards called the *Fatal Bull*; becauſe the *Deſtinies* had thus decreed, that whoſoever could ſlay him, and offer up his entrails upon an Altar, ſhould overcome the eternal Gods. *Briarens* that mighty Gyant, and ancient enemy of the Gods overcame the Bull, and was ready to have offered up his entrails according to the decree of the *Deſtinies*: but *Jupiter* fearing the event commanded the Fowls of the Air to ſnatch them away: which although to their power, they endavoured, yet there was none of them found ſo forward and apt to that action as the *Kite*, and for that cauſe he was accordinly rewarded with a place in Heaven. Some call this Conſtellation *Orvis* that is, the *Bird*: others call it *Vultur Volans*, the *Flying Grype*: It is alſo called *Gallina*, the *Hen*. Unto this Conſtellation do belong two unformed Stars.

10. CASSIOPEIA, She conſiſteth of 13. Stars. This was the Wife of *Cepheus*, and the mother of *Andromeda*, whom *Perſeus* married, and for his ſake was tranſlated into Heaven, as ſome write. Others ſay that her beauty being ſingular, ſhe waxed ſo proud, that ſhe preferred her ſelf before the *Nereides*, which were the *Nymphs* of the *Sea*: for which cauſe, unto her diſgrace, and the example of all others that in Pride of their hearts would advance themſelves above their betters ſhe was placed in the Heaven with her head as it were downwards; ſo that in the revolution of the Heavens ſhe ſeemeth to be caried head long.

11. PERSEUS, he hath 26. Stars. This was the Son of *Jupiter*, whom he in the likeneſs of a *Golden ſhower* begat upon *Danae*, the daughter of *Acriſius*. This *Perſeus* coming unto mans eſtate, and being furniſhed with the Sword, Hat, and Wings of his brother *Mercury*, and the Shield of his Siſter *Minerva*, was ſent by his foſter father *Polidectes*, to kill the Monſter *Meduſa*, whom he ſlew; and cutting off her head, carried it away with him: But as he was haſting homeward, flying in the Air, he eſpied *Andromeda* the daughter of *Cepheus* and *Caſſiopea*, for the pride of her mother, bound with a Chain unto a Rock, by the Sea ſide, there to be devoured by a Whale: *Perſeus* taking notice and pitty of the caſe, undertook to fight with the Monſter, upon condition that *Andromeda* might be his Wife; to be ſhort, he delivered *Andromeda*, married her, and returning homeward unto the Iſle *Seriphus*, he found there his grand-father *Acriſius* whom by miſchance and unadviſedly he ſlew with a quoit: (or as *Ovid* reporteth, with the terrible ſight of the horrible head of *Meduſa*, not knowing that it was his grand-father: but afterwards underſtanding whom he had ſlain, he piped away through extream ſorrow: whereupon *Jupiter* his father pittying his grief, took him up into Heaven: and there placed him in that form wherein he overcame *Meduſa*, with the Sword in one hand, and the head of *Meduſa* in the other, and the Wings of *Mercury* at his Heels. This Conſtellation becauſe of the unluckineſs thereof is called by Aſtrologers *Cacodemon* (*i. e.*) *Unluckly*, and *Unfortunate*. For (as they ſay) they have obſerved it, that whatſoever is born under this Conſtellation, having an evil aſpect, ſhall be ſtricken with Sword, or looſe his Head. *Novidius* ſaith that it is *David* with *Goliah* his head in one hand, and his ſword in the other. The unformed Stars belonging unto this Conſtellation, are three.

12. Au-

12. AURIGA, the *Waggoner*, or *Carter*: he conſiſteth of 14. Stars: the *Arabians* call him *Alaiot*; the *Greeks Heniochus*, (*i. e.*) a man holding a bridel in his hand, and ſo is he pictured, *Eratoſtenes* affirmeth him to be *Erichthonious* King of *Athens*, the firſt ſon of *Vulcan*: who having moſt deformed feet, deviſed firſt the uſe of the Waggon or Charriot, and joyned horſes together to draw the ſame, to the end that he ſitting therein, might the better conceal his deformities. For which invention, *Jupiter* tranſlated him into the Heavens.

In this Conſtellation there are two other particular Conſtellations to be noted; whereof the one conſiſteth but of one Star alone, which is in the left ſholder of *Auriga*, and is called *Hircus*, or *Capra* the *Goat*; the *Arabians* call it *Alhajoth*: The other conſiſteth of two little Stars a little beneath the other, ſtanding as it were in the hand of *Auriga*; this Conſtellation is called *Hædi*, the *Kids*. The tale is thus; *Saturn* (as you heard before) had received of the Oracle, that one of his ſons ſhould put him out of his Kingdom, whereupon he determined to devoure them all: *Ops* by ſtealth conveyed away *Jupiter*, and ſent him to *Meliſſus* King of *Crete*, to be nouriſhed: *Meliſſus* having two daughters, *Amalthæa* and *Meliſſa*, committed *Jupiter* unto their Nurſery; *Amalthæa* had a *Goat* that gave ſuck unto two *Kids*, ſo that by the milk of this *Goat*, ſhe nouriſhed *Jupiter* very well. To requite this her care and courteſie, *Jupiter* (after he had put his Father out his Kingdom) tranſlated her *Goat* and her two *Kids* into Heaven; and in remembrance of the Nurſe, the *Goat* is called *Capra Amalthæa Novidius* ſaith, that when Chriſt was born, and his birth made manifeſt by the Angels unto the Shepherds, one of them brought with him for a Preſent, a *Goat* and two young *Kids*; which in token of his good will, were placed in Heaven.

13. OPHIUCHUS, or SERPENTARIUS, That is, the *Serpent-bearer*. This Conſtellation hath no proper name, but is thus entituled, becauſe he holdeth a Serpent in his hands. It containeth 24. Stars. Some ſay that it is *Hercules*, and report the tale on this manner. *Juno* being a great enemy to *Hercules*, ſent two ſnakes to kill him as he lay ſleeping in his Cradle: but *Hercules* being a luſty Child (for *Jupiter* had ſpent two daies in begetting him) without much ado ſtrangled them both: In memorial of ſo ſtrange an evenr, *Jupiter* placed him in the Heavens, with a Serpent in his hands.

14. SER-

14. SERPENS, the *Serpent* of *Ophiuchus*, which conſiſteth of 18. ſtars. Some ſay that it is one of the Serpents that ſhould have ſlain *Hercules* in his Cradle. *Novidius* ſaith, it is the *Viper* that bit *Paul* by the hand. Others deliver the tale in theſe words; *Glaucus* the ſon of *Minos* King of *Crete*, was by misfortune drowned in a Barrel of Honey: *Minos* his father craved the help of *Æſculapius* the Phyſitian: and that he might be driven perforce to help the Child, he ſhut him up in a ſecret place, together with the dead carcaſs: whiles *Æſculapius* ſtood in a great maze with himſelf what were beſt to be done, upon a ſudden there came a Serpent creeping towards him; the which Serpent he ſlew with the ſtaff which he had in his hand. After this there came another Serpent in bringing in his mouth a certain herb, which he laid upon the head of the dead Serpent, whereby he reſtored him unto life again. *Æſculapius* uſing the ſame herb, wrought the ſame effect upon *Glaucus*. Whereupon (after that) *Æſculapius* (whom ſome affirm to be *Ophiuchus*) was placed in the Heaven, and the Serpent with him.

15. SAGITTA, or *Telum*; the *Arrow* or *Dart*. This was that Arrow wherewith *Hercules* ſlew the *Eagle* or *Grype* that fed upon the Liver of *Prometheus*, being tyed with chains to the top of the mount *Caucaſus*; and in memorial of that deed, was tranſlated into Heaven. Others will have it to be one of thoſe Arrows which *Hercules* at his death gave unto *Philoctetes*, upon which the Deſtiny of *Troy* did depend. The whole Conſtellation containeth five Stars.

16. AQUILA, the *Eagle*, which is called *Vultur Volans*, the *flying Grype*: It hath in it 9. Stars. The Poetical reaſon of this Conſtellation, is this; *Jupiter* transforming himſelf into the form of an Eagle, took *Ganimides* the *Trojan Boy*, whom he greatly loved up into Heaven, and therefore in ſigne thereof (becauſe by that means he performed his purpoſe) he placed the figure of the Eagle in the Heaven. There belong unto this Conſtellation 6. Stars (before time) unformed, but now brought into the Conſtellation of *Antinous*. But whereupon that name ſhould come, I know not, except it were that ſome man deviſed it there to curry favour with the Emperour *Adrian*, who loved one *Antinous Bithynicus* ſo well, that he builded a Temple in his honour at *Mantinea*.

17. DELPHINUS, the *Dolphin*: It containeth 10 Stars; yet

yet *Ovid* in his ſecond Book *de Faſtis*, ſaith that it hath but nine. Neither did the ancient Aſtronomers attribute unto it any more, according to the number of the Muſes; becauſe of all other Fiſhes the *Dolphin* is ſaid to be delighted with Muſick. The tale goeth thus concerning this Conſtellation. When *Neptune* the God of the Sea greatly deſired to match with *Amphitrite*, ſhe being very modeſt and ſhame-faced, hid her ſelf: whereupon he ſent many meſſengers to ſeek her out, among whom, the *Dolphin* by his good hap, did firſt find her; and perſwaded her alſo to match with *Neptune*: For which his good and truſty ſervice, *Neptune* placed him in the Heavens.

Others ſay, that when *Bacchus* had transformed the Mariners that would have betrayed him, into *Dolphins*, he placed one of them in Heaven, that it might be a leſſon for others to take heed how they carried any one out of his way, contrary both to his deſire, and their own promiſe. *Novidius* refereth this Conſtellation unto the Fiſh that ſaved *Jonas* from drowning.

18. EQUICULUS, is the little Horſe, and it conſiſteth of 4. Stars. This Conſtellation is named almoſt of no writer, ſaving *Ptolomeus*, and *Alphonſus* who followeth *Ptolomy*, and therefore no certain tale or Hiſtory is delivered thereof by what means he came into Heaven.

19. EQUUS ALATUS, the *Winged Horſe*, or *Pegaſus*, it containeth 20. Stars. This Horſe was bred of the blood of *Meduſa*, after that *Perſeus* had cut off her head, and was afterwards taken and tamed by *Bellerophon*, whiles he dranck of the River *Pirene* by *Corinth*, and was uſed by him in the conqueſt of *Chimera*: After which exploit *Bellerophon*, being weary of the earthly affairs, endeavored to fly up into Heaven. But being amazed in his flight, by looking down to the earth, he fell from his horſe; *Pegaſus* notwithſtanding continuing his courſe, (as they feign) entred into Heaven, and there obtained a place among the other Conſtellations.

20. ANDROMEDA, She conſiſteth of 23. Stars; but one of them is common both unto her and *Pegaſus*. This was the daughter of *Cepheus* and *Caſſiopeia*, and the Wife of *Perſeus* the reaſon why *Minerva*, or *Jupiter* placed her in the Heavens, is before expreſſed. *Novidius* referreth this Conſtellation unto *Alexandria* the *Virgin*, whom *S. George* through the good help of his horſe delivered from the *Dragon*.

21. TRIANGULUM, the *Triangle*, called alſo *Deltoton* becauſe it is like the fourth letter of the Greek Alphabet Δ, which they call *Delta*; it conſiſteth of four ſtars. They ſay it was placed in Heaven by *Mercury*, that thereby the head of the *Ram* might be the better known. Others ſay, that it was placed there in honour of the *Geometricians*, among whom, the Triangle is of no ſmal importance. Others affirm, that *Ceres* in times paſt requeſted *Jupiter* that there might be placed in Heaven ſome Figure repreſenting the form of *Sicilie*, an *Iſland* greatly beloved of *Ceres*: for the fruitfulneſs thereof: now this Iſland being triangular, (at her requeſt) was repreſented in the Heaven under that form.

Thus much concerning the Conſtellations of the Northern Hemiſphere. Now follow the Poetical Stories of the Conſtellations of the Southern Hemiſphere.

Secondly,

Of the Southern Conſtellations.

1. CETUS, the *Whale*, it is alſo called the *Lion*, or *Bear* of the *Sea*. This is that monſtrous fiſh that ſhould have devoured *Adromeda*, but being overcome by *Perſeus*, was afterwards tranſlated into Heaven by *Jupiter*, as well for a token of *Perſeus* his manhood, as for the hugeneſs of the fiſh it ſelf. This Conſtellation conſiſteth of 22. Stars.

2. ORION, this hath 38. Stars. The Poetical reaſon of his tranſlation into the Heavens, ſhall be ſhewn in the *Scorpion*, amongſt the Zodietical Conſtellations. The Ancient Romans called this Conſtellation *Jugala*; becauſe it is moſt peſtiferous unto Cattel, and as it were the very cut-throat of them. There are bright Stars in his girdle, which we commonly call our *Ladies yard*, or *wand*. *Novidius*, applying this ſword of *Orion* unto Scripture, will have it to be the ſword of *Saul*, afterwards called *Paul*, wherewith he perſecuted the Members of Chriſt: which after his converſion was placed in Heaven. In his left ſhoulder there is a very bright Star, which in Latine is called *Bellatrix*, the *Warriour*, in the fœminine gender. I cannot find the reaſon except it be this; that Women born under this Conſtellation

on ſhall have mighty toungs. the reaſon of the *Ox-hide* which he hath in his hand may be gathered out of the next ſtory.

3. FLUVIUS, the *River*; it comprehendeth 34 Stars. It is called by ſome *Eridanus*, or *Padus*; and they ſay that it was placed in Heaven in remembrance of *Phaeton*, who having ſet the whole World on fire by reaſon of miſguiding of his father *Phœbus* his charriot, was ſlain by *Jupiter* with a thunder-bolt, and tumbling down from Heaven, fell into the River *Eridanus*, or *Padus* which the Italians call *Po*. Others ſay that it is *Nylus*, and that that Figure was placed in Heaven becauſe of the excellency of that River, which by the Divines is called *Gihon*; and is one of the Rivers of Paradice. Others call it *Flumen Orionis* the flood of *Orion*; and ſay, that it was placed there, to betoken the off-ſpring from whence *Orion* came: for the tale is thus reported of him.

Jupiter, *Neptune*, and *Mercury*, travelling upon the Earth in the likeneſs of Men, were requeſted by *Hyreus* to take a poor lodging at his Houſe for a Night: they being overtaken with the evening, yeelded unto his requeſt; *Hyreus* made them good cheer, killing an *Ox* for their better entertainment: The Gods ſeeing the good heart of the old man, willed him to demand what he would in recompence of his ſo friendly cheer. *Hyreus* and his Wife being old, requeſted the Gods to gratify them with a Son. They to fulfill his deſire, called for the hide of the *Ox* that was ſlain, and having received it, they put it into the Earth, and made water into it all three together, and covering it, willed *Hyreus* within ten moneths after to dig it out of the Earth again; which he did, and found therein a Man-child; whom he called *Ourion*, *ab Urina*, of piſs; although afterwards by leaving out the ſecond letter, he was named *Orion*. At ſuch time therefore as he was placed in Heaven, this flood was joyned hard to his heels, and the Ox hide wherein the Gods did piſs, was ſet in his left hand, in memorial of his Off-ſpring.

4. LEPUS, the *Hare*, which conſiſteth of 12 Stars. This Conſtellation was placed in Heaven between the legs of *Orion*, to ſignifie the great delight in hunting which he had in his life time: but others think it was a frivolus thing, to ſay that ſo notable a fellow as *Orion* would trouble himſelf with ſo ſmal and timerous a beaſt as the *Hare*: and therefore they tell the tale thus.

In times paſt there was not a *Hare* left in the Iſle *Leros* : a certain youth therefore of that Iſland, being very deſirous of that kind of beaſt, brought with him from another Country thereabout, an *Hare* great with young; which when ſhe had brought forth, they in time became ſo acceptable unto the other Countrimen, that every one almoſt deſired to have and keep a *Hare*. By reaſon whereof, the number of them grew to be ſo great, within a ſhort ſpace after, that the whole Iſland became full of *Hares*, ſo that their Maſters were not able to find them meat: whereupon the *Hares* breaking forth into the fields, devoured their Corn. Wherefore the inhabitants being bitten with hunger, joyned together with one conſent, and (though with much ado) deſtroyed the *Hares*. *Jupiter* therefore placed this Conſtellation in the Heavens, as well to expreſs the exceeding fearfulneſs of the beaſt, as alſo to teach men this leſſon; that there is nothing ſo much to be deſired in this life, but that at one time or an other it bringeth with it more grief than pleaſure. Some ſay, that it was placed in Heaven at the requeſt of *Ganimedes*, who was greatly delighted with hunting the *Hare*.

5. CANIS MAJOR, the *Great Dog*, it conſiſteth of 18. Stars. It is called *Sirius Canis*, becauſe he cauſeth a mighty drought by reaſon of his heat. This is the Conſtellation that giveth the name unto the *Canicular* or *Dog daies*; whoſe beginning and end is not alike in all places, but hath a difference according to the Country and Time: as in the Time of *Hyprocrates* the Phiſitian, who lived before the time of Chriſt 400. years, the *Canicular* daies began the 13. or 14. of *July*. In the time of *Avicenna*, the *Spaniard*, who lived in the year of our Lord 1100, the *Canicular* daies began the 15. 16. or 17. of *July*. In our Country, they being about St. *James-tide*, but we uſe to account them from the 6. of *July* to the 17. of *Auguſt*; which is the time when the Sun beginneth to come near unto, and to depart from this Conſtellation.

Novidius will have it to be referred to *Tobias* Dog; which may very well be, becauſe he hath a tail; *Tobias* Dod had one; as a certain fellow once concluded: becauſe it is written that *Tobias* his Dog fawned upon his Maſter, therefore it is to be noted (ſaid he) that he had a tail. The Poets ſay, that this is the Dog whom *Jupiter* ſet to keep *Europa*, after that he had ſtolen her away, and conveied her into *Creet*, and for his good ſervice

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was placed in Heaven. Others ſay that it was one of *Orion* his Dogs. There belong unto this Conſtellation 11. Stars unformed.

6. CANIS MINOR; the *Leſſer Dog*; this of the Greeks is called *Procyon*, of the Latines *Ante Canis*; it containeth but two Stars. Some ſay, that this was alſo one of *Orions* Dogs. Others rather affirm it to be *Mera* the Dog of *Origone*, or rather of *Icarius* her father, of whom mention is made in the Conſtellation of *Bootes*, and *Virgo*. This Dog of meer love to his Maſter, being ſlain, as aforeſaid, threw himſelf into the River *Anygrus*, but was afterward tranſlated into Heaven, with *Origone*. Among the Poets there is great diſſenſion which of the two ſhould be the Dog of *Origone*; ſome ſaying one, and ſome the other, and therefore they do many times take the one for the other.

7, ARGO NAVIS, the *Ship Argo*, which comprehendeth 41. Stars; this is the Ship wherein *Jaſon* did fetch the Golden Fleece from *Colchis*, which was afterward placed in Heaven as a memorial, not only becauſe of the great Voyage, but alſo, becauſe (as ſome will have it) it was the firſt Ship wherein any man ſayled. Their reaſon why this Ship is not made whole is, that thereby men might be put in mind not to diſpair, albeit that their Ship miſcary in ſome part now and then: ſome avouch it to be the *Ark* of *Noe*. *Novidius* ſaith it is the Ship wherein the *Apoſtels* were, when Chriſt appeared unto them walking on the Sea. In one of the *Oars* of this Ship, there is a great Star, called *Canopus*, or *Canobus*, which the *Arabians* called *Shu.l*, as it were a bone-fire, becauſe of the greatneſs thereof. It is not ſeen in *Italy*, nor in any Country on this ſide of *Italy*: Some ſay that *Canobus* the Maſter of *Menelaus* his Ship was transformed into this Star.

8. HYDRA, the *Hydre*; that hath 25. Stars and two unformed.

9. CRATER, the *Cup* or *ſtanding piece*; that hath ſeven Stars, ſome ſay that this was the cup wherein *Tagathon*, that is the chief God, mingled the ſtuff whereof he made the ſouls of Men.

10. CORVUS, the *Crow*; this hath ſeven Stars. Theſe 3. Conſtellations are to be joyned together, becauſe they depend upon one Hiſtory, which is this. Upon a time *Apollo* made a ſolemne feaſt to *Jupiter*, and wanting water to ſerve his turn, he delivered a cup to the *Crow* (the bird wherein he chiefly delighted) and

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ſent him to fetch water therein. The *Crow* flying towards the River, eſpyed a Fig-tree, fell in hand with the Figs, and abode there till they were ripe: In the end, when he had fed his fill of them, and had ſatisfied his longing, he bethought himſelf of his errand, and by reaſon of his long delay, fearing a check, he caught up a ſnake in his bill, brought it to *Apollo*, and told him that the ſnake would not let him fill the *Cup* with water. *Apollo* ſeeing the impudency of the bird, gave him this gift, that as long as the Figs were not ripe upon the Tree, ſo long he ſhould never drink: and for a memorial of the ſilly excuſe that he made, he placed both the *Crow*, *Cup*, and *Snake*, in Heaven.

11. CENTAURUS, the *Centaure*, which comprehendeth 37 Stars. Some ſay, that this is *Typhon*, others call him *Chiron*, the Schoolmaſter of thoſe three excellent men, *Hercules*, *Achiles*, and *Æſculapius*: unto *Hercules* he read *Aſtronomy*, he trained up *Achilles* in *Muſick*, and *Æſculapius* in *Phyſick*: and for his upright life he was turned into this Conſtellation. Yet *Virgil* calleth *Sagittarius* by the name of *Chiron*. In the hinder feet of this Conſtellation, thoſe Stars are ſet which are called the *Croſiers*, appearing to the Mariners as they ſail towards the South Sea, in the form of a Croſs, whereupon they have their name. The four Stars which are in the Garniſh of the *Centaurs* Spear, are accounted by *Proclus* as a peculiar Conſtellation, and are called by him *Thyrſilochus*, which was a Spear compaſſed about with vine leaves: but they are called by *Copernicus* and *Clavius*, and other Aſtronomers, the Stars of his Target. It ſhould ſeem that they were deceived by the old tranſlation of *Ptolomie*, wherein *Scutum* is put for *Haſta* (*i. e.*) the Target, for the Spear, as it is well noted by our Countryman M. *R. Record*, in his Book intituled *The Caſtle of knowledge*.

12. LUPUS, the *Wolf*, or the beaſt which the *Centaure* holdeth in his hand, containeth 19. Stars; the Poetical reaſon is this, *Chiron* the *Centaure* being a juſt man, was greatly given to the worſhip of the Gods: for which thing, that it might be notified to all poſterity, they placed him by this beaſt, which he ſeemeth to ſtick and thruſt through with his Spear, (as it were) ready to kill for ſacrifice.

13. ARA, the *Altar*, it is alſo called *Lar*, or *Thuribulum*, (*i. e.*) a Chilmney with the fire, or a Cenſor. It conſiſteth of ſeven Stars, and is affirmed of ſome Poets, to be the *Altar* where-

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on the *Centaure* was wont to offer up his ſacrifice. But others tell the tale thus. When as the great Gyants called the *Tytans*, laboured as much as might be to pull *Jupiter* out of Heaven, the Gods thought it good to lay their heads together, to adviſe what was beſt to be done: Their concluſion was, that they ſhould all with one conſent joyn hands together to keep out ſuch fellows: and that this their league might be confirmed, and throughly ratified; they cauſed the *Cyclops*, (which were work-men of *Vulcan*) to make them an Altar: about this Altar all the Gods aſſembled, and there ſware, that with one conſent they would withſtand their enemies; afterwards, having gotten the Victory, it pleaſed them to place this Altar in Heaven, as a memorial of their League, and a token of that good which unity doth breed.

14. CORONA AUSTRINA, the *South Garland*, it hath 13. Stars. Some ſay that it is ſome trifling *Garland* which *Sagittarius* was wont to wear, but he caſt it away from him in jeſt, and therefore it was placed between his legs: others call it the Wheel of *Ixion*, whereupon he was tormented for that great diſcourteſy he would have offered unto *Juno*, thinking indeed to have gotten up her belly: but *Jupiter* ſeeing the impudency of the man, tumbled him out of Heaven (whereby the licence of the Gods he was ſomtime addmitted as a gueſt) into Hell, there to be continually tormented upon a Wheel. The Figure of which Wheel was afterwards placed in Heaven, to teach men to take heed how they be ſo ſaucie to make ſuch courteous proffers unto other mens wives. The Greeks call this Conſtellation by the name of *Uraniſcus*, becauſe of the Figure thereof: For it repreſenteth the palate or roof of the mouth, which they call *Uraniſcus*.

15. The laſt is PISCIS AUSTRINUS, or *Notius*, the *South Fiſh*, which comprehendeth 11 Stars beſides that which is in the mouth thereof, belonging to the water, which runneth from *Aquarius*, and is called by the Arabians *Fomahant*. The reaſon why this *Fiſh* was placed in the Heaven, is uncertain: yet ſome affirm, that the daughter of *Venus* going into a water to waſh her ſelf, was ſuddenly transformed into a fiſh; the which fiſh was afterwards tranſlated into Heaven. The unformed Stars belonging unto this Conſtellation are ſix.

Thus much concerning the Conſtellations of the Northern and Southern Hemiſpheres; now follow the Poetical Stories of the Zodiatical Conſtellations.

Thirdly,

Thirdly.

Of the Zodietical Conſtellations.

1. ARIES, the *Ram*, it is called by the Greeks *Crios*, it containeth in it 13. Stars, which were brought unto this Conſtellation by *Thyeſtes*, the ſon of *Pelops*, and brother of *Acreus*. This is the *Ram* upon which *Phrixus*, and *Helle* his ſiſter, the children of *Athamas* did ſit, when they fled from their ſtep-mother *Ino*, over the Sea of *Helleſpont*: which *Ram* was afterwards for his good ſervice, tranſlated into Heaven by *Jupiter*. Others ſay, that it was that *Ram* which brought *Bacchus* unto the ſpring of water, when through drought he was likely to have periſhed in the deſert of *Lybia*. *Novidius* will have this to be the *Ram* which *Abraham* offered up inſtead of his ſon *Iſaac*. The Star that is firſt in the head of the *Ram*, is that from whence our later Aſtronomers do account the Longitude of all the reſt, and it is diſtant from the head of *Aries*, in the tenth Sphere, 27. degrees 53. minutes. The unformed Stars belonging unto this Conſtellation, are five.

2. TAURUS, the *Bull*, which conſiſteth of 23. Stars. This was tranſlated into Heaven in memorial of the rape committed by *Jupiter* on *Europa* the daughter of *Agenor*, King of *Sidon*; whom *Jupiter* in the likeneſs of a white Bull ſtole away, and tranſported into *Candia*. Others ſay, That it was *Io* the daughter of *Inachus*: whom *Jupiter* loved, and turned into the form of a Cow, to the intent that *Juno* coming at unawares, ſhould not perceive what a part he had played: *Jupiter* afterward in memorial of that crafty conveyance, placed that Figure in Heaven; The reaſon why the Poets name not certainly whether it be a Cow or a Bull, is becauſe it wanteth the hinder parts; yet of the moſt of them it is called a *Bull*. In the Neck of the *Bull* there are certain Stars ſtanding together in a cluſter, which are commonly called the *ſeven Stars*; although there can hardly be diſcerned any more than ſix. Theſe are reported to be the ſeven daughters of *Atlas*, called *Atlantiades*, whereof ſix had company with the immortal Gods, but the ſeventh (whoſe name was *Merope*) being married unto *Syſiphus* a mortal man, did there

therefore withdraw and hide herſelf, as being aſhamed that ſhe was not ſo fortunate in matching herſelf as her ſiſters were. Some ſay; that that ſtar which is wanting is *Electra*, the eldeſt daughter of *Atlas*, and that therefore it is ſo dim, becauſe ſhe could not abide to behold the deſtruction of *Troy*; but at that time and ever ſince, ſhe hid her face. The reaſon why they were taken up into Heaven, was, their great pitty towards their father, whoſe miſhap they bewayled with continual tears. Others ſay, that whereas they had vowed perpetual virginity, and were in danger to loſe it, by reaſon of *Orion*, who greatly aſſayled them, being overtaken with their love; they requeſted *Jupiter* to ſtand their friend; who tranſlated them into ſtars, and placed them in that part of Heaven. The Poets call them *Pleiades*, becauſe when they riſe with the Sun, the Mariners may commit themſelves to the Sea. Others will have them to be ſo termed *a pluendo*; becauſe they procure rain. Others give them this name, of the Greek word *Cleiones*, becauſe they be many in number, They be alſo called *Vergiliæ*, becauſe they riſe with the Sun in the *Spring time*: likewiſe *Athenaiæ*, becauſe they ſtand ſo thick together. Our men call them by the name of the *ſeven Stars*, or Brood Hen. The Aſtronomers note this as a ſpecial thing concerning theſe ſtars, that when the Moon and theſe ſtars do meet together, the eys are not to be medled withall, or cured if they be ſore: their reaſon is, becauſe they be of the nature of *Mars* and the *Moon*.

Moreover, there be five ſtars in the face of the *Bull*, repreſenting the form of the *Roman* letter V, whereof one (which is the greateſt) is called the *Bull's Ey*. they be called *Hyades*, and were alſo the daughters of *Atlas*, who ſo long bewayled the death of *Hyas* their brother, ſlain by a *Lyon*, that they died for ſorrow, and were afterwards placed in Heaven, for a memorial of that great love they bear to their brother. The ancient *Romans* call the *Bull's Ey Parilicium*, or *Palelicium*, of *Pales* their goddeſſe; whoſe feaſt they celebrated after the conjunction of this ſtar and the Sun. The unformed ſtars belonging unto this Conſtellation, are eleven.

3, GEMINI, the *Twins*; it conſiſteth of 18. ſtars. The Poets ſay they are *Caſtor* and *Pollux*, the ſons of *Leda*, brethren moſt loving, whom therefore *Jupiter* tranſlated into Heaven. Some ſay that the one of them is *Apollo*, and the other *Hercu-*

les: but the moſt affirm the former. The unformed Stars of this Conſtellation are ſeven, whereof one is called *Tropus*, becauſe it is placed next before the foot of *Caſtor*.

4. CANCER, the *Crab*, it hath 9. Stars. This is that *Crab* which bit *Hercules* by the heel as he fought with the Serpent *Hydra* in the Fen *Lerna*, and for his forward ſervice, was placed in Heaven by *Juno*, the utter enemy of *Hercules*. In this Conſtellation there are Stars much ſpoken of by the Poets; although they be but ſmall; whereof one is called the *Crib*, other two are the two *Aſſes*, whereof one was the *Aſſe* of *Bacchus*, the other of *Vulcan*, whereon they rode to battel, when as the Gyants made war with the Gods; with whoſe braying and ſtrange noiſe, the Gyants were ſo ſcared upon the ſudden, that they forſook the field, and fled. The Gods getting the Victory, in tryumphing manner tranſlated both the *Aſſes*, and their manger into Heaven. The unformed Stars of this Conſtellation are four. It is called *animal Retrogradum*, for when the Sun cometh into this Signe, he maketh Retrogradation.

5. LEO, the *Lyon*, it hath 27. Stars, this is that *Lyon* which *Hercules* overcame in the wood of *Nemæa*, and was placed in Heaven in remembrance of ſo notable a deed. *Novidius* ſaith, this was one of the *Lyons* which were in the den into which *Daniel* was caſt, and was therefore placed in Heaven, becauſe of all other he was moſt friendly unto *Daniel*. In the breaſt of this Conſtellation is that notable great Star, the light whereof is ſuch, as that therefore it is called by Aſtronomers *Bazilcus* or *Regulus* (*i. e.*) the *Viceroy*, or little King among the reſt. The unformed Stars belonging to the *Lyon* are eight; whereof three make the Conſtellation which is now called *Coma Berenices*, that is, the hair of *Berenice*. This Conſtellation was firſt found out and inventedby *Canon* the Mathematician, but deſcribed by *Calimacchus* the Poet. The occaſion of the Story was this, *Ptolomeus Evergetes* having married his ſiſter *Berenice*, was ſhortly after enforced to depart from her, by reaſon of the Wars he had begun in *Aſia*; whereupon *Berenice* made this vow, that if he returned home again in ſafety, ſhe would offer up her hair in *Venus* Temple. *Ptolomie* returned ſafe; and *Berenice*, according to her vow, cut off her hair and hung it up. After certain daies, the hair was not to be found; whereupon *Ptolomie* the King was greatly diſpleaſed: but *Canon*, to pleaſe the humor of the King, and to curry

ry favour with him, perſwaded him that *Veuus* had conveyed the Hair into Heaven. *Canon* attributeth ſeven Stars unto it, but *Ptolomie* allotteth it but three, becauſe the other be inſenſible.

6. VIRGO, the *Virgin*, it hath 26 Stars. This is affirmed to be Juſtice, which among all the Gods ſometime living upon the Earth, did laſt of all forſake the ſame, becauſe of the wickedneſs that began to multiply therein, and choſe this place for her ſeat in Heaven.

Others ſay, that it was *Aſtræa*, the daughter of *Aſtræus*, one of the Gyants that were called *Titans*, who fighting againſt the Gods, *Aſtræa* took their parts againſt her own Father, and was therefore after her death commended unto the Heavens, and made one of the 12 Signes.

Others ſay, that it was *Erigone*, the daughter of *Icarius*, who for that her father was ſlain by certain drunken men, for very grief thereof hangd her ſelf: but *Jupiter* taking pitty of the *Virgin* for her natural affection, tranſlated her into Heaven.

In her right wing there is one Star of ſpecial note, which by the Aſtronomers is called *Vindemiator*, (*i.e.*) the gatherer of Grapes. This was *Ampelos* the ſon of a Satyr and a Nymph, and greatly beloved of *Bacchus*, unto whom in token of his love, *Bacchus* gave a ſingular fair Vine, planted at the foot of an Elm, (as the manner was in old time.) But *Ampelos* in Harveſt gathering Grapes, and taking little heed to his footing, fell down out of the Vine, and brake his neck. *Bacchus* in memorial of his former affection, tranſlated him into Heaven, and made him one of the principal Stars in this Conſtellation. There is another great Star in the hand of the *Virgin*, called of the Latines *Spica*, of the Greeks *Stachus*, of the Arabians *Azimech* (*i.e.*) the *Ear of Corn*: whereby they ſignifie, that when the Sun cometh to this Signe, the Corn waxeth ripe. *Albumazar* the Arabian, and *Novidius*, take this Conſtellation for the Virgin *Mary*. The unformed Stars in this Conſtellation are ſix.

7. LIBRA, the *Ballance*, it containeth 8 Stars; *Cicero* calleth it *Jugum* the *Yoak*, and here it is to be noted, that the Ancient Aſtronomers that firſt ſet down the number of the Conſtellations contained in the Zodiack, did account but eleven therein, ſo that the Signe which now is called *Libra*, was heretofore called *Chel i.* that is to ſay, the *Claws of the Scorpion*, which poſſeſſeth the ſpace of two whole Signes. But the latter Aſtronomers, being deſirous

ſtrous to have 12. Signes in the Zodiack, called thoſe eight whereof the *Claws of the Scorpion* do conſiſt, by the name of *Libra*; not that there was any Poetical Fiction to induce them thereto, but only moved by this reaſon, becauſe the Sun joyning with this Conſtellation, the Day and the Night are of an equal length, and are (as it were) equally poyzed in a pair of Ballance. Yet (as I remember) ſome will have this to be the Ballance wherein Juſtice, called alſo *Aſtræa*, weighed the deeds of mortal men, and therein preſented them unto *Jupiter*. It hath 9. unformed Stars appertaining unto it.

8. SCORPIO, the *Scorpion*; called of the *Arabians*, *Alatrab*; of *Cicero*, *Nepa*. It Conſiſteth of 21. Stars. The Fiction is thus; *Orion* the ſon of *Hyreus* greatly beloved of *Diana*, was wont to make his boaſt, that he was able to overcome what beaſt ſoever was bred upon the Earth: The Earth being moved with this ſpeech brought forth the *Scorpion*, whereby *Orion* was ſtung to death. *Jupiter* thereupon (at the requeſt of the Earth,) tranſlated both the *Scorpion* and *Orion* into Heaven; to make it a leſſon for ever, for mortal men, not to truſt too much unto their own ſtrength: and to the end he might ſignify the great enmity between them, he placed them ſo in the Heaven, that whenſoever the one ariſeth, the other ſetteth; and they are never both of them ſeen together above the Horizon at once: *Gulielmus Poſtellus* will have it to be the *Serpent* which beguiled *Eve* in Paradiſe. The unformed Stars about this *Scorpion* are three.

9 SAGITTARIUS, the *Archer*. It hath thirty one Stars. Touching this Signe, there are among the Poets many and ſundry opinions. Some ſay that it is *Crocus*, the ſon of *Pupbene*, that was nurſe unto the Muſes. This *Crocus* was ſo forward in learning of the liberal ſciences and in the practiſe of feats of activity, that the Muſes entreated *Jupiter* that he might have a place in Heaven. To whoſe requeſt *Jupiter* inclining, made him one of the 12 Signes: And to the end that he might expreſs the excellent qualities of the Man, he made his hinder parts like unto a Horſe, thereby to ſignify his ſingular knowledge in Horſe-manſhip: and by his Bow and Arrow, he declared the ſharpneſs of his Wit. Whereupon the Aſtrologers have this conceit, that he that is born under *Sagittarius*, ſhall attain to the knowledge of many Arts, and be of prompt wit, and great courage. *Virgil* affirmeth this to be *Chiron* the *Centaur*, who for his ſingular learning and Juſtice

was

was made the Maſter of *Achilles*. At which time *Hercules* coming to viſit him (for he had heard both of the worthineſs of the School-maſter, and of the great hopes of the Scholler) brought with him his quiver of Arrows dipped in the blood of the Serpent *Hydra*; but *Chiron* being deſirous to ſee his ſhafts, and not taking heed of them being in his hand, let one of them fall upon his foot, and being greatly tormented, not only by the anguiſh of the poyſon working in the wound, but much more becauſe he knew himſelf to be immortal, and his wound not to be recovered by medicine, he was enforced to make requeſt unto the Gods, that he might be taken out of the World, who pittying his caſe, took him up into Heaven and made him one of the 12 Signes.

10. CAPRICORNUS, the *Goat*, it conſiſteth of 28 Stars. The Poets ſay, that this was *Pan*, the God of the ſhepheards, of whom they feign in this manner: The Gods having war with the Gyants, gathered themſelves together into *Ægypt*, *Typhon* the Gyant perſued them thither, whereby the Gods were brought into a quandary, that well was he that by changing his ſhape might ſhift for himſelf. *Jupiter* turned himſelf into a *Ram*: *Apollo* became a *Crow*: *Bacchus* a *Goat*: *Diana* lurked under the form of a *Cat*: *Juno* transformed herſelf into a *Cow*: *Venus* into a *Fiſh*: *Pan* leaping into the River *Nilius*, turned the upper part of his body into a *Goat*, and the lower part into a *Fiſh*. *Jupiter* wondring at his ſtrange device, would needs have that Image and Picture tranſlated into Heaven, and made one of the 12. Signes. In that the hinder part of this Signe is like a Fiſh, it betokeneth that the latter part of the moneth wherein the Sun poſſeſſeth this Signe, enclineth unto Rain.

11. AQUARIUS, the *Waterman*. It hath 42. Stars, whereof ſome make the Figure of the Man: other ſome the Water pot: and ſome, the ſtream of water that runneth out of the pot. This is feigned to be *Ganimedes* the *Trojan*, the ſon of *Oros*, and *Callirhoe* whom *Jupiter* did greatly love for his excellent favour and beauty, and by the ſervice of his Eagle carried him up into Heaven, where he made him his Cup bearer, and called him *Aquarius*. Others notwithſtanding think it to be *Deucalion* the ſon of *Prometheus* whom the Gods tranſlated into Heaven, in remembrance of that mighty deluge which happned in his time, whereby mankind was almoſt utterly taken away from the face of the earth. The unformed ſtars belonging unto this Signe are three:

12. PISCES, the *Fiſhes*: theſe, together with the line that knitteth them together, contain 24. Stars. The Poets ſay that *Venus* and *Cupid* her ſon coming upon a certain time unto the River *Euphrates*, and ſitting upon the bank thereof, upon a ſudden eſpyed *Typhon* the *Gyant*, that mighty and fearfull enemy of the Gods coming towards them; Upon whoſe ſight, they being ſtricken with exceeding fear, lept into the River, where they were received by two Fiſhes, and by them ſaved from drowning. *Venus* for this good turn, tranſlated them into Heaven. *Gulielmus Poſtellus* would have them to be the two Fiſhes wherewith Chriſt fed the 5000. Men. The unformed Stars of this Conſtellation, are four.

Thus have I breifly run over the Poetical reaſons of the Conſtellations: It remains now that I ſpeak of the *Milky way*.

VIA LACTEA, or *Circulus Lacteus*, by the Latines ſo called; and by the Greeks *Galaxia*; and by the Engliſh, the *Milky way*. It is a broad white Circle that is ſeen in the Heaven: in the North Hemiſphere, it beginneth at *Cancer*, on each ſide the head thereof, and paſſeth by *Auriga*, by *Perſeus*, and *Caſſiopeia*, the *Swan*, and the head of *Capricorn*, the tayl of *Scorpio*, and the feet of *Centaur*, *Argo* the *Ship*, and ſo unto the head of *Cancer*. Some in a ſporting manner do call it *Watling ſtreet*, but why they call it ſo, I cannot tell; except it be in regard of the narrowneſs that it ſeemeth to have; or elſe in reſpect of that great high way that lieth between *Dover* and S. *Albons*, which is called by our men, *Watling ſtreet*.

Ovid ſaith, that it is the great Cauſey, and the high way that leadeth unto the Pallace of *Jupiter*; but he alledgeth not the cauſe of the whiteneſs: belike he would have us imagine that it is made of white Marble.

Others therefore alledge theſe cauſes: *Jupiter* having begotten *Mercury* of *Maia* the daughter of *Atlas*, brought the child when he was born, to the breaſt of *Juno* lying aſleepe: But *Juno* awaking threw the child out of her lap, and let the milke run out of her breaſt in ſuch aboundance that (ſpreading it ſelf about the Heaven) it made that Circle which we ſee. Others ſay, that it was not *Mercury*, but *Hercules*; and that *Juno* did not let the milk run out of her breaſt, but that *Hercules* ſuckt them ſo earneſtly, that his mouth run over, and ſo this Circle was made.

Others ſay; that *Saturn* being deſirous to devour his children, his

his wife *Ops* presented him with a stone wrapped in a clout, instead of his child: This stone stuck so fast in *Saturn* his throat as he would have swallowed it, that without doubt he had therewith all been choaked, had he not been relived by his wife, who by pressing the milk out of her breasts saved his life: the milk that missed his mouth (whereof you must suppose some sufficient quantity) fell on the Heavens, and running along made this Circle.

Dr. Hood *Commenting upon Constellations saith*; The Stars are brought into Constellations, for Instruction sake, things cannot be taught without names: to give a name to every Star had been troublesome to the Master, and for the Scholler; for the Master to devise, and for the Scholler to remember: and therefore the Astronomers have reduced many Stars into one Constellation; that thereby they may tell the better where to seek them; and being sought, how to express them, Now the Astronomers did bring them into these Figures, and not into other, being moved thereto by these three reasons: first these Figures express some properties of the Stars that are in them; as those of the *Ram* to be hot and dry; *Andromeda* chained betokeneth imprisonment, the head of *Medusa* cut off signifieth the loss of that part: *Orion* with his terrible and threatning gesture, importeth tempest and terrible effects. The *Serpent*, the *Scorpion*, and the *Dragon*, signify poyson: The *Bull* insinuateth melancholy passion: The *Bear* inferreth cruelty, &c. Secondly, the Stars (if not precisely, yet after a sort) do represent such a Figure, and therefore that Figure was assigned them: as for example, the *Crown*, both North and South, the *Scorpion*, and the *Triangle*, represent the figures which they have. The third cause was the continuance of the memory of some notable Men, who either in regard of their singular pains taken in Astronomy or in regard of some other notable deed, had well deserved of Man-kind.

The first Author of every particular Constellation is uncertain; yet are they of great antiquity; we receive them from *Ptolomie*, and he followed the *Platonicks*; so that their antiquity is great. Moreover we may perceive them to be ancient by the Scriptures, and by the Poets. In the 38. Chapter of *Job* there is mention made of the *Pleiades*, *Orion*, and *Arcturus*, and *Mazzaroth*, which some interpret the 12. Signes: *Job* lived in the time of *Abraham*, as *Syderocrates* maketh mention in his Book *de Commensurandis locorum distantijs*.

Now

Now beſides all this, touching the reaſon of the invention of theſe Conſtellations, the Poets in ſetting forth thoſe Stories, had this purpoſe, to make men fall in love with Aſtronomy: When *Demoſthenes* could not get the people of *Athens* to hear him in a matter of great moment, and profitable for the Common-wealth, he began to tell them a tale of fellow that ſold an Aſs; by the which tale he ſo brought on the *Athenians*, that they were both willing to hear his whole Oration, and to put in practice that whereunto he exhorted them. The like intent had the Poets in theſe Stories: They ſaw that Aſtronomy being for commodity ſingular in the life of Man, was almoſt of all men utterly neglected: Hereupon they began to ſet forth that Art under theſe Fictions; that thereby ſuch as could not be perſwaded by commodity, might by the Pleaſure be induced to take a view of theſe matters, and thereby at length fall in love with them. For commonly note this, that he that is ready to read the Stories, cannot content himſelf therewith, but deſireth alſo to know the Conſtellations, or at leaſtwiſe ſome principal Star therein.

FINIS.

A Diſcourſe OF THE *Antiquity, Progreſs,* AND *Augmentation* OF ASTRONOMIE.

Article. I. *Obſervations Cœleſtial, from the beginning of the World; though rude and in-artificial.*

FIRST it ſeems not to be doubted, but that there was ſome kind of obſervation of Bodies Cœleſtial, as ſoon as there were Men: conſidering that the ſpectacle which the Heavens conſtantly preſent, is both ſo glorious, and ſo uſefull, that men could not have eyes to ſee, and not fix them attentively and conſiderately thereupon. For, among other Apparences when they ſaw the Sun dayly to change the places of its riſing and ſetting; at certain times of the Year: to aproach neerer to the Earth in its Diurnal arch, and at others again to mount up to a height much more ſublime and remote from it: and that his coming neerer to the Earth made *Winter*, and his remove higher made *Summer*: we ſay, when they beheld theſe things; doubtleſs, they could not but ſeriouſly remark and conſider this viciſſitude, according to which they might expect the Seaſon would be more hard, or mild, to them in this lower Region of the World. Again, ſo admirably various did the Moon appear, in her ſeveral ſhapes and dreſſes of light, that ſhe could not but invite mens eyes, and engage them to frequent Speculations: eſpecially when ſhe aſſumed thoſe various faces or appearences, at ſet and certain Times; in reſpect whereof it came to paſs, that every Nation meaſured their Times and Seaſons, by thoſe her conſtant and periodical

riodical circuits; and this, becauſe thoſe periods ſucceded much more frequently, than the Erections and Depreſſions of the Sun. To theſe, we may add that beautifull ſhew of the Nightly Stars, undergoing likewiſe their Variations, according to the variety of Seaſons; and more particularly that bright ſtar of *Lucifer*, riſing ſometimes later, ſometimes earlier, and ſometimes not at all before the Sun, and the like. But, what we ſhall principally note, is only this; that though Mankind was long, before they came to make inquiries into the Cauſes of theſe Cœleſtial changes and variations, reſtrained to ſet periods: yet they obſerved them from the very firſt Age, and not only admired, but alſo accommodated what they obſerved, to the uſes of their Lives and their Succeſſors. Here it might not be fruitleſs, to remember, that PROMETHEUS, who was imagined to have framed the firſt Man, was alſo imagined to have given him an erected Figure, and ſublime Countenance; to the end he might the more advantageouſly advance his eyes to the Heavens, and contemplate the glory and motions of the Cœleſtial Lights. But, becauſe this is too General, and rude a way of obſervation; and it is our buſineſs to look back into thoſe times *wherein men firſt made ſuch Obſervations of Syderal bodies, as gave them the hint and occaſion of reducing them to Method, and founding the principles of the Art, or ſcience of Aſtronomy, thereupon*: we muſt have recourſe to the monuments in *Sacred Writ*, for the underſtanding of that obſcure matter.

Artic. II. *Sacred records examined, and Moſes found to be the Firſt Aſtronomer there ſpoken of. lib. 1. Ant. c. 3.*

And indeed, the light we expect from *Sacred Leaves*, would ſoon be clear enough to diſcuſs all the darkneſs, wherein the Original of Aſtronomy ſeems involved; could we but from them deduce the leaſt evidence for that which the learned Antiquarie among the Jews, *Joſephus* affirms of the Sons of *Seth*; *viz. that they invented the ſcience of the Heavens, before the Flood, and engraved the ſame on two Pillars, the one of Brick, the other of Stone, that ſo it might be preſerved in the one, in caſe the fury of the Deluge to come, ſhould demoliſh and deface the other*: or if there remained to us any the moſt ſlender teſtimony of the Reaſon he there gives, of the ſo great Longevity of men in thoſe dayes; namely, that the duration of their lives was ſufficiently long, to perfect the knowledge of Aſtronomy, which requires full 600. Years, at the leaſt, to the obſervation of all the Varieties of Cœleſtial motions: Whereupon He notes, that the Great Year (as they call it) doth conſiſt of ſix hundred common Years; the vulgar opinion being, that the Cœleſtial Motions do continually vary. *Donec*

cap. 4.

Donec conſumpto, Magnus qui dicitur, Anno,
Rurſus in antiquum redeant vaga ſidera curſum,
Qualia præteriti ſteterant ab origine mundi.

Epigram. de ætat. Anim.

Again, the buſineſs might be deduced from not long after the Flood, if in Scripture we could find but the leaſt word from whence might be argued the truth of what the ſame Author writes; namely, that the *Egyptians were taught Aſtronomy, by Abraham.* Probable enough it is, we confeſs, that *Beroſus*, and others, quoted aſwell by *Joſephus*, as *Euſebius*, had read ſome ſuch thing in ſome Book of the old Rabbins: but that the ſame ſhould be fetched from Holy Writ, is moſt improbable, therein being no mention at all of any ſuch thing. Beſides, there are pious and learned Doctors, and among them *Salianus*, who will not allow it to be ſo much as probable, that *Abraham* ſhould inſtruct the *Egyptians* in Aſtronomy: becauſe of the very ſmal time of his ſtay among them in *Egypt*. It is written indeed, that *Abraham came from Ur of the Chaldeans*: but not that he received Aſtronomy from the *Chaldeans*, or that he delivered it from them to the *Egyptians*. And therefore they conclude, that what *Joſephus* ſaid of *Abrahams* reading Aſtronomy in *Egypt*, may with more probability be imputed to his Great-grand Child, *Joſeph*. Concerning Him, therefore, we read (in truth) that he was ſingularly favourable to the Prieſts in *Egypt*, at ſuch time, as all the reſt of the People mortgaged their Lands to the King, for bread, during that wofull and long Famine. For, He excepted the Lands belonging to the Prieſthood, and (as the Text ſaith) aſſigned them certain portions out of the publique Granaries; ſo that from hence may be proved (what *Ariſtotel* tells us from other Authority) that amongſt the Egyptians, the moſt ancient Nation, the Prieſts were exempted from labour, and left to the eaſy imploiment of their minds: and that this gave them occaſion to invent and conſtitute the Mathematiques: and yet for all this, it is not written, either that *Joſeph* taught thoſe Egyptian Prieſts the Mathematiques, or that they taught them to him. And, perhaps that Favor He ſhewed the Prieſts, was an argument not only of the reſpect and Veneration born them by the King and all his people; but alſo of his particular Gratitude toward them; in that He, who had been bred up only to Sheppardry and Coun-

Gen. 11.

Gen 47.

1. *Polit. cap.* and 1. *Metaph. cap.* 1.

try imployments, and was wholy ignorant of all Arts and Sciences, at his first comming among them; being afterwards advanced to the height of a Courtier, and lusture of a Favorite, had bin instructed by them in something more noble and sublime. And truly the Divine *Moses*, not long after admitted into the same Court, is not delivered so much to have erudited any others, as to have been himself learned in all the Wisdom of the Egyptians. Nevertheless, considering that this Wisdom of the Egyptians, doubtless contained the Mathematiques; and that Astronomy, was ever esteemed the best and noblest part of them: this Erudition of *Moses* seems to be the most ancient monument of the Science of the Stars, that can be found in Holy writ.

Act. 7.

Astronomy you see is of great Antiquity, even upon the Records of Divinity; and might be proved of much greater, could we but evince (what some alleadge) that the History of *Job* was pen'd by *Moses*, as living a good while after him. Because *Job* there mentions *Arcturus*, *Orion*, and the *Hyades*, or watery Constellation: and therefore it must be, that before that time the Stars had been ranged and dispossed into certain Asterisms, according to some certain method or artificial Theory then in use. But, be the time of his life never so uncertain, yet we may certainly observe from the History thereof; that it seems *Job*, being an Alien to the Hebrews, derivied his knowledge of God from that which in Scripture is called, *Cœlorum Exercitus*, the *Host of Heaven*. Forasmuch, as the Invisible things of God are not so well learned from any visible things of nature, or the effects of his Wisedom and Power, as from the Cœlestial Orders, and therefore *Synesius* justly calling Astronomy [ὑπερτίμενον ἐπιστήμην] *a truly-venerable Science*; he saith that it advanceth the mind to somthing of greater both Antiquity and Nobility, *viz.* ineffable Theology. That we may be breef, and only touch upon that sentence in the Book of Wisedom that God gave to *Solomon*, among other of Natural Sciences, to *understand the Course of the Year, and the dispositions of the Stars*: if any thing in Sacred writ doth expressly prove the Antiquity of Observations Astronomical, and the founding or erecting any setled Art thereupon; it must be that, of which the Holy Prophets complaind in their daies; *viz.* that there were Chaldeans, who at *Babilon did contemplate the Stars, and compute the Months, that from them they might foretell things to come*. For, from hence we understand, that the observations of the Motions of Heavenly bodies was a certain

Cap. 9.

de done ad Pæon.

cap. 7.

Esa 47.

tain profest Art; and of great Antiquity, among the *Chaldeans*.

In the *Second* place, we are to revolve the Records of *Ethnick Authors*, to see if among them we can find the time of the Nativity of Astronomy. Artic. 3. Ethnick monuments likewise revolved; and first those of Fabulous times: according to which Cœlus is found the most ancient Astronomer:

Look we therefore back, first, into the remains of that part of Time, which is called *Obscure*, or *Fabulous*; because possibly enough something of truth, concerning our enquiry, may be found wrapt up in the darksome shrouds of Fables. And begin we at the most ancient of Heathen Gods, *Cœlus*, in Greek Οὐρανὸς, who, as *Diodorus Siculus* delivers, was so named, because of his high devotion to, and delight in the observation of the Stars. This eminent person being the Father of many Sons as *Atlas*, *Saturnus*, the *Titanes*, and among those especially *Hyperion* and *Japetus*; it is lawfull for us to conjecture, that led by his example, his whole family were addicted to the same Study. For seeing, that *Cœlus* lived in *Mauritania*, not far from the Ocean; and thence extended his Kingdom not only over all *Africa*, but also into a considerable part of *Europe*: it is well known that his Son *Atlas*, who succeded him in the same Dominions, is allowed to have given his name to the highest Mountain of that Country; only because he had made his observations of the motions of the Heavens and Stars, from the top thereof. For the Ancients in those daies, as the vulgar now in ours, imagined the arch of the Heavens to be so little distant from the tops of great Mountains; as that by how much the higher any man ascended on those hills, by so much the more clearly and distinctly might he behold Cœlestial objects. To this, *Diodorus*, *Plinie*, and others add; that *Atlas* was feigned to support Heaven on his Shoulders, only because He had framed a Sphere, wherein the whol Heavenly machine was strongly represented: and *Clemens Alexandrinus* observes, that *Hercules*, being both *Vates* and *Physicus*, a Prophet and Philosopher, was reported to come and relieve *Atlas* (his great Uncle) by taking the vast Burden of Heaven upon his own Shoulders; because He succeded him in that difficult task the Study, or science of Cœlestial bodies. Of *Hesperus*, the Son of *Atlas*, it is recorded, that while he was busy in speculating the Stars, on the top of the same mountain, he was snatched away by the violence of some disease, and could never be found: and that thereupon, the common people, in respect of his piety and justice, gave his name to the most beautifull and resplendent Star, which is also called *Vesperugo*, being *Venus*, while

and after him his Sons.

1. Atlas, who taught Astronomy to his Son.

lib. 3.

lib. 2. *cap.* 8.

Astron. 1.

Hesperus.

And Daughters, the Atlantides *and* Pleiades, *from one of whom came* Mercury.

ſhe is in the Weſt. As for his Siſters, called both *Atlantiades*, and *Pleiades*; theſe likewiſe gave their name to that glomeration of Stars, which are viſible in the back of *Taurus*: and of one of them, named *Maia*, was born the Famous *Mercurius*, ſaid to have brought the Science of the Stars firſt into *Egypt*. Whence *Marcilius*, writing of the Aſtronomy of the *Egyptians*, Saies of *Mercury*.

1 Aſtron.

Tu Princeps, Authorq;, ſacri, Cyllenie, tanti. &c.

Though we well know, that the *Ethiopians*, allowing the *Egyptians* to be no other, but one of their *Colonies*, ſent abroad to find room to ſubſiſt in, contend; that they received Aſtronomy from them: as firſt *Diodorus*, and after *Lucian* have obſerved. Here it is well worthy our commemoration, what *Cicero* ſaith, as of *Atlas* and *Prometheus*, ſo alſo *Cepheus*, a King of " the *Ethiopians*: *viz.* " Neither had *Atlas* been believed to have ſuſtain'd Heaven, nor " *Prometheus* to have been chain'd on *Caucaſus*: nor *Cepheus* with " his Wife, Son-in Law, and Daughter, to have been Stellified: " had not their Divine cognition of Cœleſtial bodies firſt occaſi- " oned the perpetuation of their Names in the diſguiſe of Fables.

lib. 3. *lib. de Aſtrol.* *5. Tuſculan.*

2. Saturn, *who delivered the ſame to his Son.*

To return to *Saturn* another ſon of *Cœlus*; He, leaving *Africa*, and reigning only in *Italy*, *Sicily* and *Crete*; may be thought to have proſecuted his Fathers ſtudies, no leſs than the former: and we have this argument for it, that the ſloweſt of all the Planets bears his name, to this very Day; probably, becauſe he was the firſt who underſtood the motion and Courſe of that Planet, which was by the *Greeks* called Κρόνος from χρόνος Time, foraſmuch as of all the Cœleſtial Circuits, none was found ſo diuturn. And of his Sons, ſince *Pluto* addicted himſelf intirely to Husbandry, *Neptune* to Navigation; we may conceive, that *Jupiter*, applying his mind to nobler cares, ſucceded his Father in the Study of the Heavens: as alſo that he choſe *Olympus*, accounted the higheſt mountain, to make his obſervations upon: ſo that in proceſs of time he came therefore to be called *Olympus*; and the name of that mountain to be transferred upon Heaven it ſelf; whoſe orders and laws He well underſtanding, was thereupon ſaid to have the Dominion of Heaven. Certain it is, that the *Grecians* aſcribed the Original of this nobleſt Science, partly to the *Gods* themſelves, and partly to ancient *Hero's*: which *Achilles Tatius* ſeaſonably alluding unto, introduceth old *Æſchylus* attributing to God, that He ſhewed the Riſings

Jupiter.

Iſagog ad Phœn.

Riſings and Settings of the Stars, and diſtinguiſh't Winter, Summer, and the other Seaſons; and *Ovid* Fathers the ſame wholly upon *Jupiter*.

Perq; Hiemes, Æſtusq;, & in æquales Autumnos,
Et breve Ver, ſpatiis exegit quatuor Annum. 1. Metamorph.

Beſides, it is in the Fiction, that *Jupiter* took his Father, *Saturn*, bound him, and precipitated him into Hell. Now this ſeems to intimate, that *Jupiter* having impoſed his own name upon one of the moſt eminent and illuſtrious of the Planets, gave that of his Father to another of them, that was more remote, ſituate in the deepeſt parts of the Ætherial ſpaces, and of the ſloweſt progreſs: though all this while we are not ignorant, that thoſe names were fixed upon thoſe *Planets* a long time after: ſince more anciently the *Planet Jupiter* was called *Phaeton*, and that of *Saturn*, *Phœnon*. For, we may collect very neer as much from *Lucian*, who by *Tartarus* underſtands the immenſe Altitude, or Profundity of the Ætherial Region: and ſo denies that *Saturn* was either exil'd by *Jupiter* into Hell, or caſt into bonds; as common heads were perſwaded to beleeve.

As for *Hyperion*; *Diodorus* hath a tradition, that he being of the progeny of old *Cœlus*, demonſtrated the courſes of the Sun and Moon: and therefore called the Sun *Helios*, after the name of his Son; and the Moon, *Selene*, after that of his Daughter. 3. Hyperion.

Laſt of all comes *Japetus*, who alſo was the Son of *Cœlus*, but performed nothing worthy commendation in the advance of his Fathers Speculations: but *Prometheus*, whom he begat, was therefore imagined to have been chained on the hill *Caucaſus*, and to have his heart perpetually torn by a hungry Eagle or Vultur; Because (as *Servius* expounds the riddle) with reſtleſs care, and ſolicitude of mind, he conſtantly excruciated himſelf with obſerving the Stars, and ſtudying their Aſcenſions and Declinations. We ſhall not inſiſt upon what follows in the ſame Author, namely that this *Prometheus* was the firſt, who introduced *Aſtrology* to the *Aſſyrians* (not far from *Caucaſus*:) it being more uſefull for us now to obſerve, that He was imagined to have ſtolen Fire from Heaven, for the inanimation of Man, for no other reaſon, but becauſe he infuſed this Heaven-fetch't Knowledge into the breaſts of men, and inflamed their ſouls with the deſire and love thereof. 4. Japetus. *from whom came* Prometheus, *who followed the ſame ſtudy in Eccl. 7*

For,

For, as to the remainder; for as much as *Belus* was the same with *Jupiter*, among the *Assyrians*, as *Diodorus* testifieth: it is He rather, who was accounted both the most sacred of their Dieties, and the Inventor of this Sideral Science; as *Pliny* affirms.

lib. 2.
lib. 37. *c.* 10.

So did Phaeton,

It is not needfull for us here to examine many other of the ancient Traditions, accounted likewise among the Fabulous; as, in particular, the Fable of *Phaeton*, which hath this Mythology, that in his life time he had made a considerable progress toward the discovery of the Suns Annual course; but dying immaturely, he left the Theory thereof imperfect. That other of *Bellerophon*, whom Interpreters maintain to have been carried up to Heaven, not by a flying horse, but a studious and contemplative mind, eager in the quest of Syderal mysteries. That of *Dædalus*, who indeed, by the same towring speculations, as by the artifice of wings, mounted up to the Northern part of Heaven; while his less ingenious Son, *Icarus*, falling short in his attempt of imitating his Fathers sublime flight (as not so well understanding the demonstrations of the reasons of his Theory) flagged very low in his Studies: and fell from the true and apodictical; cognition of Coelestial motions and vicissitudes: with many other the like recounted by *Lucian*; as that of *Endymion*, the favourite of the Moon, of *Tiresias*, the Prophet, &c. Yet one thing there is mentioned as well by *Lucian*, as *Tatius*; which we cannot well pass by; which falling under the account of Heroical times, seems to come somwhat neer to that which is called Historicall. And that is the notable Contention that arose betwixt *Atreus* and *Thyestes* about supreme dominion. For when by the publike Consent and Vote of the *Argives*, the Kingdom was to be his of the two, who should give the most eminent testimony of Science: it came to *Atreus* share to be King: because, though *Thyestes* shewed them the signe *Aries*, in Heaven (for which he was honored with a golden Ram) yet had *Atreus* declared a thing more excellent: while discoursing about the variety of the Suns risings, He made it appear, that the Sun and the World (*i.e.* the Starry Orb) were not carryed the same, but quite contrary wayes; and consequently, that that part of the Heavens which was the *West* or *Occident* of the Starry Orb, was the very rising, or *Orient* of the Solary. Hence that verse of *Euripides*,

Dædalus, Icarus,

de Astrol. in Isagog.

Atreus *and* Thyestes.

Δείξας γὰρ ἄστρων τὴν ἐναντίαν ὁδὸν

Qui Astrorum enim contrariam ostendi viam.

To

To the same times likewise are we to refer the Institution of the Olympick Games, by *Hercules*; which after a long interruption were renewed by *Iphitus*. For, inasmuch as those sports were instituted for no other end (as may be assured from *Censorius*) but that their celebration might put men in mind of that *Intercalation* of a month and half, that was to be made constantly every fourth Year, in respct of those four times eleven, or 44. Dayes, by which the motion of the Moon anticipated that of the Sun; and the four times six hours, or one whole Day, by which the circruit of the Sun exceded 365 Dayes: manifest it is, that *Hercules* could not understand this, without having first exactly observed the Motions of the Sun and Moon. Hither also belongs that which is reported of *Orpheus*, who must needs have attentively observed the seven *Planets*, if it be true, as *Lucian* averrs, that he represented their Harmony by his *Seven-stringed Harp*: which the *Grecians* thereupon designed in Heaven, by some stars, that to this Day retain the name of *Lyra*. So likewise doth what *Sophocles* saith of *Palamedes*, who pointed out the several Asterisms, and particularly:

Hercules *and* Iphitus.

cap. 18.

Orpheus.

de Astrol.

Palamedes.

Ἄρκτου Στροφάς τε, καὶ κύνος ψυχρὰν δύσιν
Vrsum volutam: gelidum & occasum Canis.

And lastly, what *Homer* recounts, that in those times were well known (besides *Bootes* and the *Bear*, or *Wain*)

Homer.

Πληϊάδας, θ' Ὑάδας τε, τὸ σθένος Ὠρίωνος
Pleiades, atq; Hyades, roburq; ipsum Oriones.

Odiss. E.

We have now struggled through the Darkness of Fabulous Times, and are advanced as far as to discerne the twilight of *Historical*. An here, the first thing we clearly perceive, is that the whole Controversy abovt the Antiquity of Astronomical Observations lies betwixt the *Egyptians* aud the *Assirians*, or *Babylonians*. For, as to the *Grecians*, though some have thought they might put in also for a claim to the honour of being the Authors of this admirable Science; yet by the Verdict even of *Plato* himself, they are to lay by the pretence of competition, "For saith He, the first that made Syderal inspections, was a "*Barbarian*; a more ancient Nation than ours bred those men,

Articl. 4.

Secondly, those Historical *times; according to which, the antiquity of Astron. Observations belongs either to the* Egyptians, *or* Babylonians. *in Epinom.*

"who first devoted their minds to that Study, in respect of the "Sumer-like sereneity and perspicuity of the Air, such as *Egypt* "enjoyes, and *Syria*, where all the Stars are clearly visible, and "no Clouds or Mists to obscure the beautifull face of Heaven. And certainly, if we except what we newly mentioned, the Institution of the *Olympick Games* by *Hercules*, and the restauration of them after some Intermision, by *Iphytus*, which hapned about 800. Years before Christ; and some places in the writings of *Homer*, and more especially of *Hesiod*, who lived neer upon the same time, or not long before; we shall find that the *Grecians* can produce no Monuments of their Observations of the Heavens, more ancient then those of *Thales*, who flourisht full 600. Years before Christ; and who yet borrowed his knowledge of Ætherial Maters from *Eygpt* It being manifest therefore, that the *Ægyptians*, or their Priests, are the only men, that ought to be admitted to a Dispute with the *Assirians* or *Babilonians*, or their Philosophers, concerning the Antiquity of Observations, and that their several Pleas seem equally reasonable. Truly, it is no easie matter to determine the difference, so as to place the Lawrel on their heads to whom it doth of right belong. For, albeit *Josephus* assignes the Honour to the *Caldæans*, and others again stand firmely for the *Egyptians*: yet *Plato*, *Diodorus*, *Lucian*, *Achilles*, *Tatius*, and others aleadge such quotations for each party, as seem to have no other, but the authority of the parties themselves. Nor ought that to seem strange; since both sides equally alleadge the convenience of their vast Companies, and the serenity of the sky; since they both boast themselves the Original Nation, and allow their Competitors to be only *Colonies*; since both glory in fabulous beginnings, which we cannot trace or discusse; and both recur to egregious falshoods about the time when their Ancestors first made Cœlestial Scrutenies. For, the *Caldæans* (as we find on the Register of *Diodorus*) affirm, that their Nation applied themselves to these Studies, from times of incredible Antiquity, *viz.* of four hundred and three thousand Years: And the *Egyptians* (as *Cicero* observes) talke of Observations of four hundred thousand and seventy Years standing. Unless you shall please to consigne the Victory to the *Egyptians*, because they put a value only themselves by Auction. As if it were not enough for them to boast those four hundred nine thousand Years (mentioned by *Laertius*) in which from the time of *Vulcan*, the son of *Nilus*, to that of *Alexander* of *Macedon*,

1. Antiq. 8. in Epinom. 2. lib. de Astrolog. Isagog.

loc. citat.

de Divinat.

Macedon, there hapened of *Eclipses* of the Sun three hundred seventy three, and of the Moon eight hundred thirty two. These considerations premised, we cannot indeed deny but the *Egyptians* had some Observations, some ages before *Thales* and other *Grecians* travelled among them: but, when we would enquire more precisely into the time, when those Observations first began; we find our selves at a loss, and brought back again into the cimmerian obscurity of Fabulous Times. *in præfa.*

Now forasmuch as, though *Pliny* writes, that *Epigenes* found no Observations among the *Babilonians* of above seven hundred and twenty Years antiquity, and those engraven on artificial Tyles or Slates; and the most ancient *Eclipses* deduced from them, were transmitted to *Ptolomy*, about the same Number of Years before Christ: and that by the great *Hipparchus*. And to the same Time belongs what *Berosus* and *Critodemus* say, that in their Daies, there were extant no Observations of more than four hundred and thirty Years, as may be found also in *Pliny*: forasmuch, we say, as we have brought some considerable Monuments of Observations much elder than that time; yet shall not concede beyond what the *Chaldeans* themselves profest, when they testified to *Callisthenes* (who went to them upon no other errand, by the perswasion of *Aristotel*, as *Simplicius* relates) that they had nothing of that kind among them beyond a thousand nine hundred and three Years past: which Years seem to commense at *Ninus*, the Son of *Belus*, and first King of the *Assyrians*. It is clear, that the Antiquity of Observations ariseth to (but not above) one thousand and ninety Years before *Alexander* the Great. *lib. 9. c. 56.* *in Almagest. lib. 4. cap. 6.* *in lib. 2. de Cœlo, and comment. 46.*

But, alas! after all this great ado, *What did the Observations themselves amount to?* Why truly, for ought we can gather from all that is extant concerning them, those of the *Egyptians* amounted to nothing at all: and those of the *Chaldeans* to very little. For the *Egyptians*, we confess, are said to have observed the rising of the Dog-Star, and some other, no very difficult apparences: but we have no remains delivered down to us, of that or any other particular they observed, with the exact designation of the Time, as they ought. And from the *Chaldeans* we have as little, besides those *Eclipses* mentioned in *Ptolomy*. But, when I speak of the *Egyptians*, I except *Ptolomy* himself, and some others who lived and studied at *Alexandria*, about three hundred Years before the Nativity of our Saviour; or after *Alexander*: as *Timocharis*, *Eratosthenes*, Article. 5. *Yet neither of them observed any thing considerable; as to the designation of Times: but corrupted what they had observed, to the Introduction of* Astrology Judicial.

nus, *Hipparchus*: for all these were either *Grecians*, or to be accounted among *Grecians*, in respect of the language they used and wrote in, rather than among the ancient *Egyptians*, by whose Inventions even *Ptolomy* himself (one of their own Country men, without dispute) was very little, or nothing at all assisted in his Study of Astronomy. But, what concerns aswell the *Egyptians*, as *Chaldeans*; their Observations are to be distinguisht (according to the division vulgarly received) into (1.) *Astronomical*, and (2.) *Astrological*: the former relating to the Motions, Magnitudes, Distances, and Proportion of the Stars; the Latter to the Effects of them, which they conjectured were dependent on the Vertues and Influences of Heavenly Bodies, aswell in the affections of the Air, as in the actions and affairs of Mankind. For, both Nations being wonderfull prone to Superstition, and surprised with excess of Admiration at the *Eclipses* of the Sun and Moon, when they first beheld them; and observing ever now and then some Stars that moved in Courses contrary to the *West*, they began presently to think, that those apparences hapned not without natural Causes; and that it remained only on Mans part, to Study how those events might come to be fore-known, which those apparences did portend. Hereupon, having attributed the most powerfull Vertue to the five wandering Stars (as *Diodorus* testifieth particularly of the *Chaldeans*) as understanding them to be the Proclaimers of the will and purposes of the Gods; because they sometimes arose, and sometimes set in various places of the Heavens; because they varied their magnitude and colour: therefore they conceived, that they ought to adress their Studies and Disquisitions principally to these varieties. And, because they imagined, that the higher the place was, from whence they should observe these Wandering Stars, the more clearly and distinctly might they be discerned; they builded Structures of vast altitude; and particularly that immense Tower at *Babylon*, described by *Herodotus*, from the highest area whereof (where stood also the Temple of *Belus*) they might exactly behold and observe the rising and setting of the Stars, and other Syderal occurrences. They took notice likewise, that those five *Planets* did keep almost the same Course, as the Sun and Moon; and thereupon they pointed out the Zodiack, imagining that there must be some eminent vertue in that part of the Heavens, because all the *Planets* kept constantly to it. And this Zodiack they divided

loc. citat.

Lib. 1.

vided into 12. parts, or Signes; becauſe the Moon run it over 12. times, and the Sun only once in one Year: and according to the number of the Daies, during which the Sun was in paſſing through one Signe, they diſtinguiſhed each Signe again into 30. parts, which we call Degrees. I ſhall not recount to you, how they would have Twelve Principal Dieties belonging to theſe 12. Signes, whereof each had his particular regiment over his proper Signe and Moneth dependent thereupon: nor how they ſubſtituted thirty of the fixt Stars, to aſſiſt the *Planets*, and called them *Councelling Gods*: nor how they placed 12. Stars alwaies viſible in the North, for goverment of the Living; and as many more in the South, alwaies viſible, for the government of the Dead, there gathered together; with many other the like dreams and ridiculous abſurdities. But the thing I think moſt worthy your notice, is, *by what rude kind of artifice they diſtinguiſhed the Zodiack into* 12. *Signes*; as we find it deſcribed, concerning the *Chaldeans*, by *Sextus Empiricus*, and concerning the *Egyptians*, by *Macrobius*. *ad Aſtrolog.* 1. *in Somn.* 21.

The manner this. They took a veſſell with a ſmall hole is the bottom, and filling it with Water, ſuffered the ſame to diſtill Drop by Drop into another Veſſell, placed beneath to receive it; and this from the moment of the riſing of ſome one Star or other, obſerved in one Night, untill the Moment of its riſing again the next night following. The Water fallen down into the Receiver, they divided into 12. equal parts, and having two other ſmaller Veſſels in readineſs, each of them fit to contain one twelfth part of the Water, they again poured all the Water into the upper Veſſel, and ſtrictly marking the riſing of ſome one Star in the Zodiack, they at the ſame Moment gave the Water leave to diſtill into one of the ſmaller Veſſels, and ſo ſoon as that was filled, obſerving likewiſe another riſing Star, they put under another ſmall Veſſel; and ſo alternately ſhifting the ſmall Veſſels, they noted, if not in one Night, yet in many, the twelve Stars, by which they might diſcriminate the whole Zodiack into twelve equal parts. Now with what Art and exactneſs theſe Ancients meaſured out the Heavens, may be conjectured from this one example. I might adferr another foppery of the *Chaldeans*, from the ſame *Empiricus*, who relates; that taking it for granted, that the future fortunes of Men did depend on their particular Horoſcope, or Signe riſing at their Birth; when they had a

mind to divine in this Kind; Two of theſe wiſe men agreed together in the Calculation of the Nativity of the Perſon propoſed: the one ſtood by the Mother in Travell, the other on ſome high place neer at hand; and as he that was below gave the Signe, that the Infant was then newly come into the World, the other above took care to obſerve the Signe, that was juſt then newly riſen.

ibid cap. 20. But, it will be of more uſe for us to hear what *Macrobius* tells of the *Egiptians*. They, when they would know the Diameter of the Sun, had in readineſs a Veſſell of Stone, hollowed to the form of an Hemiſphere, exactly made, with a ſtyle or Gnomon erected in the middle, and twelve Horary Lines drawn within: And on the very Day of the Equinox, obſerving the Moment, when the upper Limbus of the Sun firſt ſhewed it ſelf above the Horizon; they marked that place on the brim of the Veſſell, on which the Gnomon caſt its ſhadow. Then again marking that place, on which the ſhadow ended, when the lower Limbus of the Suns body appeared juſt above the edge of the Horizon; they meaſured the ſpace or diſtance betwixt the two marks of the Shadows, and found it to be the ninth part of an hour, or the hundred and eight part of the Hemiſphere, and conſequently the two hundred and ſixteenth part of the whole Circuit: and from thence they deduced, that the Diameter of the Sun was the two hundredth and ſixteenth part of its whole Orb; (which, in truth, is the 700th neer upon) or did contain one Degree and an hundred Minutes; which yet is no more than half a Degree, or 31. Minutes, at moſt. To this we might ſuper-ad, that it was the practiſe of elder times, to commenſurate the Diameter of the Sun by an Hydrologie, or Veſſell of Water; collecting the ſame from part of the Water flowing down the whole Day, which had dropped untill the Sun was wholly riſen; as is inſinuated by *Plutarch*, and deduced from *Capella*: but *Cleomedes* hath at large declared, that this way of meaſuring by Water falling ſlowly and equally from Veſſell to Veſſell, was an Invention of the *Egyptians*. Now the reaſon, why we touch upon theſe particulars, was only to ſatisfy, that (as we ſaid afore no great matter in Aſtronomy was ever obſerved either by the *Egyptians*, or by the *Babylonians*.

And, if you deſire any further Argument thereof; Pray take this. They were very far from ſuſpecting, that the Fixt Stars had any motion proper to themſelves; or that they had any Eccentricity

tricity (excepting only that the *Egyptians* thought *Venus* and *Mercury* to move round about the Sun, as their center; as is affirmed by *Macrobius*, and ſome others) or that the Sun had any *Apogæum* at all; with many other Particulars fully as conſiderable. Which doubtleſs muſt be the reaſon, why they invented no *Hypotheſes*, by which they might regulate themſelves, in making their calculations of the various motions of the heavenly bodies. And *Peter Ramus* not long ſince complanied, that we have not our *Aſtronomy* free from the trouble of *Hypotheſes*; ſuch as the Inrerpreters of *Ariſtotel* themſelves, and *Proclus* on *Timeus* have recorded the *Egyptians* and *Babilonians* to have had amongſt them: while, introth, he complaind, that we had not our *Aſtronomy* as rude wild and imperfect, as theirs was. For, however ſome *Hypotheſes* are more ſimple (and ſo more eaſy) than other-ſome: yet it is abſolutely impoſſible, that *Aſtronomy* ſhould conſiſt without ſome or other. Hereupon, they could obſerve, indeed, that the Planets were one while Direct in their Progreſs, another while Retrogarde, and then again Stationary that they in their wanderings ſometimes inclined towards the *North*, and ſometimes deflected again toward the *South*: but all that while, they could neither comprehended the reaſons of thoſe various apparences, nor calculate them by numbers. The moſt they could doe, was darkly to repreſent thoſe motions, by certain *Hieroglypicks*, as in particular by the windings and flexures of Serpents; and the motion of the Sun, only by a Beetle rowling his pill of dung backward: as we may read in *Clements Alexandrinus*: and then came *Eudoxus*, who having learned that variety of motions among them, was the firſt who invented *Hypotheſes* of various Orbs, for the Solution of the *Phenomena*.

Again, they were very far from attaining the determinate places of the Fixt Stars, according to Longitude and Latitude; or according to their Right Aſcenſion, and Declination, ſo that neither could they define the true places of the Planets, by Comparation to the Fixt Stars, nor (conſequently) deſigne any Obſervations with due exactneſs. And truely, this was the Cauſe why *Hypparchus* met with no obſervations, either of the *Egyptians* or *Babilonians*, by which he could receive the leaſt help or advantage, toward his compoſing either *Hypotheſes*, or Tables to repreſent the motions of the Five errant Stars: and *Ptolomy* was the firſt, who partly by the benefit of Obſervations left

left him by *Hipparchus*, and partly by thoſe he made himſelf, became able to attempt ſuch a Work; as ſtands recorded in his *Almageſt*. There were only the *Eclipſes*, which both theſe Nations had ſet down: as obſerved in their Commentaries: and thoſe only ſo, as that from Paſt, they might be able to conjecture ſomthing of what were to Come. Not from the motions of Sun and Moon, exactly Calculated by the help of Tables; but having learnd from common experience, that every nineteenth Year, *Eclipſes* did return again upon the ſame Day, for the moſt part: thereupon they endeavoured to prædict what *Eclipſes* would happen, and the time when; and this after they had perceived not any *Anomaly* in the Sun, but ſome certain Inequality in the Moon, which reducing to a medium, they concluded that the Moon did every Day run through thirteen Degrees, and a little more than one ſixth part of a degree; as *Geminus* delivers of the *Chaldeans*. But in their predictions of *Lunar Eclipſes*, they were ſomwhat more confident; aſwell becauſe theſe *Eclipſes* uſually uturne, for the three Ages next ſucceding, within the compaſs of the ſame Daies; as becauſe it is very rare, in reſpect of the greatneſs of the Earths ſhadow, but the Moon, either in the whole, or ſome part of her, more or leſs, falls into it: but, becauſe (as to *Solary Eclipſes*) the Moon is both ſo ſmal, and hath ſo large a Parrallax, as that ſhe doth not for the moſt part intercept the light of the Sun from the Earth; therefore was it (as *Diodorus* witneſſeth ſpecially of the *Babylonians*) that they durſt not determine *Eclipſes* of the Sun to come, to any certain time; but if they predicted any, with limitation of time, they alwaies (to ſave their credit, in caſe of failing) annexed this Condition, *If the Gods be not prevailed upon, by Sacrifices and Praires, to avert them.*

Truth is, theſe *Aſtronomers* were alſo Prieſts, and it was their intereſt to caſt in this Proviſo. For, being ambitious to be reputed interpreters of the will of the Gods to the People, and ſo both knowing in things to come, and skillfull in ſuch Ceremonies, wherewith their reſpective Deities were moſt attoned and delighted: unwilling to be thought able to predict nothing, and as unwilling again to be found erring in their chief predictions, they wrapt up all in miſteries, and amuſed the vulgar with ſuperſtitious opinions and rites. The *Egyptians*, in a great part of their ſacred Worſhip, had recourſe to the *Aſtrologicel* Books

of

of their *Mercurius*, (one of the Order of the Fixt Stars; a ſecond, of the Conjunction of Sun and Moon; a third and fourth, of their riſing) which with what ceremonious Pomp they uſed to carry about with them, in a kind of ſolemne Proceſſion, you may find amply deſcribed by *Clem. Alexandrinus*. Nor is it ſtrange that thoſe Prieſts accounted ſo ſacred and knowing, ſhould alſo be eſteemed for Prophets. Further, you meet with no mention of the Five Errant Stars, all this while; and the reaſon ſeems to be, becauſe they attributed an energie of them only as they were referrable to the Inerrant or Fixt: and particularly, as they poſſeſt this or that part of ſome Signe in the Zodiack, and together with it had their riſing, or ſetting. For, ſo much did they aſcribe to the Zodiack, as that the *Babylonians*, and (in imitation of them, the *Perſians* and *Indians*) thought, that each decimal of Degrees, or Thirds of the Signes, (and the *Egyptians* came as low as to each ſingle Degree) could not be varied in the riſing, but ſome eminent variation muſt happen, eſpecially in him, who ſhould be born at that time. And hereupon was it, that the *Egyptians* made that great Circle of Gold (deſcribed in *Diodorus*) of a cubit in thickneſs, and three hundred ſixty five cubits in circumference (plundered at laſt by *Cambyſes*) that upon each cubits ſpace might be inſcribed each Day of the Year, 365. Daies in the whole round, and alſo what Stars did riſe, what ſet upon each Day, nay the very hour of their reſpective riſing and ſetting, and what they did ſignifie: and whereas others uſed to aſſigne the form of ſome Animal or other, to each ten Degrees; they aſſigned one to each ſingle Degree, and ſo made their hariolations or conjectural predictions accordingly. For Example; to the firſt Degree of *Aries* they aſſigned the figure of a Man, holding a Sicle or hook in his right hand, and a Sling in his left; to the ſecond, a Man with a Dogs-head, his right hand ſtretcht forth, and a ſtaff in his left; and ſo of the reſt: then annexing the ſignification to each, they determined, that he, who ſhould have the firſt Degree of *Aries* for his Horoſcope, ſhould be ſome part of his life a Husbandman, and the reſt of it a Soldier; that he, who ſhould be born under the ſecond, ſhould be contentious, quarrelſome, and envious; and ſo of the reſt, all which *Scaliger* hath fully deduced from *Aben Ezra*. In a Word; what ever knowledge either the *Egyptian* or *Chaldeans* had of the Stars; certain it is, they referred it wholly to

lib 6 Aſtronom.

Aſtronomantie, or Divination by Stars: and therefore among them there flouriſht, no true and genuine *Aſtronomy*, but a ſpurious and falſe, one, *i. e. Aſtrology Divinatory*, or the fraudulent Art of Fortune-telling by the Heavens.

Beroſus (whom we formerly mentioned) coming into *Greece*, a little after the death of *Alexander*, is diſcovered to have brought with him nothing ſollid touching *Aſtronomy*, but only Judicial *Aſtrology*; for which, as a thing new, and ſtrange to the People, he was highly eſteemed, as *Vitruvius* and *Pliny* remark. And *Eudoxus*, who had returned out of *Egypt* before that, well knew what ſort of *Aſtrology* this was (the principal Contrivers and Founders of which are ſaid to have been *Petoſiers*, *Necepſus*, *Eſculapius*) but he highly contemned it, as *Cicero* remembers, and brought home no other fruit of his tedious Travells, beſides a liſt of ſome *Eclipſes*, and the varieties of the motions of the wandering Stars, by which he firſt eſſaied to compoſe accommodate *Hypotheſes*, as we have formerly hinted. Nay, *Plato* himſelf, who was Companion to *Eudoxus*, for thirteen Years together, in *Egypt*, profeſt, that he could attain nothing ſollid and ſatisfactory, touching thoſe Stars, and therefore placed all his hope only in the ſagacity and induſtry of the *Grecians*, ſuch as he knew *Eudoxus* to be. "For, having firſt recounted what ever he knew concerning "them; he ſaith, It is to be beleeved that the *Grecians* make more "perfect whatſoever they receive from *Barbarians*; and therefore "it is fit, we allow the ſame, touching the argument of which "we have diſcourſed. Truth is, it is difficult to find out the way, "how all theſe Apparences, ſo involved in obſcurity, may be ex-"plicated: nevertheleſs there is great hope that things of that ſort "will be better and more advantageouſly handled, than they "were delivered to us by *Barbarians*.

lib. 9. cap. 7. *lib. 7. cap. 37.* *2. de divinat.* *in Epinom.*

Artic. 6. *And after them to the* Grecians *among whom the moſt ancient mention of Aſtron. is in* Heſiod.

From the *Egyptians* and *Chaldeans*, therefore (as *Aſtronomy* her ſelf, while young and rude) we come to the *Grecians*: and the moſt antique record of Syderal Obſervations to be found among them, ſeems to be that of *Heſiod*, who in his Book of Weeks and Daies teacheth Husbandmen the moſt opportune times of reaping, ſowing, and other labours of Agriculture, from the riſing and ſetting of the *Pleiades*, and *Hyades*, and *Arcturus*, the *Dog-ſtar*, and *Orion*:

Πληϊάδων Ἀτλαγενέων ἐπιτελλομενάων.

Donec Pleiades, quæ & Atlantiades, exoriuntur, &c.

And

And I cannot tell, whether it were that Book, or some other, that *Pliny* meant, when speaking of *Hesiod*, he saies, *Hujus quoq;, nomine extat Astrologia*, there is extant an *Astrology* of his. However, we are here to remark two things, in order to our more exact disquisition; the *First* is, that the Ancient *Greeks* principally attended to these risings and settings, aswell that they might distinguish the several Seasons of the Year, as that they might fore-know Rain, Wind and other dispositions of the Air, usually attending those Seasons. And hereupon, *Thales*, *Anaximander*, *Democritus*, *Euctemon*, *Meton*, *Eudoxus*, and many others, composed certain *Parapegmata*, Tables, (as Ephemerides, or Diaries) in which they inscribed each Day of the Year, with the particular Stars rising or setting on each Day, and what mutations of the Air each one did portend. Such a *Parapegme* as these, was composed likewise by *Julius Cæsar* himself, for the Horizon of *Rome*; in allusion where-to he might justly own, what *Lucan* said for him, *Ex Gem. Ptol. & aliis.* *lib.* 10.

Nec meus Eudoxi fastis superabitur Annus.

And, him doubtless, did *Ovid* translate into his *Fasti*; promising in the beginning, that he would sing of the Stars and Signes, that rose and again descended under the Earth. But, to keepe close to the *Grecians*; among them, he was held a great Astrologer, who had discovered and observed only these risings and settings here spoken of; and so of whom that might be spoken, which *Catullus* said of *Conon*, *lib.* 1.

Omnia qui magni dispexit lumina Mundi,
Stellorumq; ortus comperit, atq; obitus.

For, before the Advent of *Berosus*, this was the only ['*Episemasia.*] Præsignification or Divination by the Stars, the *Grecians* had omong them: unless what *Hesiod* hints, in his *in diedus.*

Πρῶτον ἕνη τετ'ς τε, καὶ ἑδόμη, ἱερὸν ἦμαρ,
Primum prima dies, & quarta & septima sacra, &c.

where he points out, what Daies of the Moon were accounted Lucky, and what Unlucky.

The *Second* observable is; that among the *Grecians*, and indeed among divers other Nations, beyond all Memorials of either Traditions or Books, the Stars were reduced to certain Images or Constellations, and denominated accordingly (as their names yet shews) as it pleased the fancies of Husbandmen, Shepheards, Mariners and the like, who used to be vigillant and gazing upon the Heavens in clear Nights. Though there have been some Constellations added of latter times, as that of the *lesser Wain*, by *Thales*, which *Laertius* and *Tatius* recite out of *Caltimachus*, who also took the same elswhere, and that of *Berenices Hair*, removed into Heaven by *Conon* as *Catullus* relates. *Cleostratus* likewise (as we have it from *Hyginus*) found out the *Kids*: though, (which *Pliny* moreover attributes to him,) his invention of the Signes in the Zodiack, is so to be understood, as that he taught men through what Signes the Sun and other *Planets* passed. But (that we may touch also upon this) at first, the *Grecians* had only Eleven Signes in their Zodiack; and it was long after ere they came to add the Twelfth, in imitation of the *Egyptians*, who (as may be collected from *Servius*, *Marcianus*, and others) in stead of the *Clawes* of the *Scorpion*, placed *Libra*, the place destined to *Augustus*, by *Virgil*,

lib. 1. de vit. Isagog de Com. Beren.
lib. 2. Astron. l. 2. cap. 8.
in 1. Geog. l. 8.

1. Georg. ---- *Ipse tibi jam brachia contrahit ardens Scorpius.* ----

They added the Twelfth, we say, to the end, that as the whole Compass of the Zodiack was divided into *Dodecatemoria* (as they call them) twelve equal parts, so it might consist also of twelve Signes. Albeit, being (as it were) necessitated to make use of such Signes, as had been brought up, rather by chance, than Art; those 12. Signes were not exactly proportionate to the 12. Divisions of the Zodiack, but took up more space some, than others: as in particular, *Leo* possest more room than *Cancer*; *Taurus* than *Gemini*. I say, than *Gemini*, which though composed of *Castor* and *Pollux*; in so little space as is allowed them, it is impossible the one should Rise, when the other Sets, and both in the *East*: but this *Empiricus* interprets of the two *Hemispheres*. I omit to insist upon this, that all Nations had not the same Constellations: as among the *Egyptians* was no *Bear*, no *Cepheus*, no *Dragon*; but other forms or representations, as *Tatius* reports; and shall add only, that *Eudoxus* seems

1. adven. Physic.

ſeems to have been the firſt, who partly out of the *Egyptian* Figures, partly out of the *Grecian*, furniſhed the whole Zodiack with Images reſembling the *Aſteriſmes*, (as men had fancied, at leaſt) and cauſed them to be drawn on a Globe, or ſolid Sphere. For, *Aratus* (upon whoſe Poem, intitul'd φαινόμενα, *Apparences*, there have been ſo many Commentaries ſet forth, as that no fewer then forty have been extant in Greek; beſides thoſe of *Cicero*, *Germanicus*, *Avienus*, and other Latin Interpreters) did no more, but only expreſs in verſe, what *Eudoxus* had ſaid before in proſe, of this argument; as *Hipparchus*, *Bythinus* demonſtrates. I know not whether it would be ſeaſonable for me, here to advertiſe, that it is no wonder *Aratus* erred ſo groſly in many particulars; conſidering that (as it written in his life) he Living with *Antigonus Gonata*, in the quality of his Phiſician, and *Nicander* in the quality of his Aſtrologer; and both were good at Poetry: *Antigonus* commanded the Phyſician to give him a tryall of his Poeſie, upon an Argument in Aſtrology; and the Aſtrologer to give another of his, upon ſomthing in Phyſick: delivering to the one, the Book of *Eudoxus*; and to the other, all that was extant of *Treacles*, *Antidotes*, or *Counterpoiſons*. So each wrote of what he did not well underſtand. One thing I ſhall not forget; and that is, that the *Phenomena* of *Euclid*, who lived neer about the ſame time, and taught at *Alexandria* (as in the Memorials of *Pappus*) were quite of another kind; being indeed no other, but certain Principles of *Aſtronomy*, concerning the figure of the World, and the Circles of the Sphere, and chiefly, that of the Zodiack.

lib. 1 in Arat. Phæn.

lib. 7.

But, to return back to the more Primitive *Greeks*; I remember I ſaid, that *Thales Meleſius* was accounted the Firſt, who after old *Heſiod* and *Homers* Daies, enquired into the Order of the Stars. And, certainly He was the Man, who among the *Grecians* may challenge the Palme; as to Antiquity; for, *Apuleius* calls him, *ut antiquiſſimus, ſic peritiſſimus Aſtrorum Contemplator*, and *Eudemus* in *Laertius* atteſteth, that this was the Opinion of moſt, adding moreover, that *Xenophanes* and *Herodotus* highly admired him, for that he had firſt predicted the *Eclipſes* and Converſions of the Sun; and that *Heraclitus* and *Democritus* witneſſeth as much. And whereas *Apuleius* further ſubjoynes, that he found out the motions and oblique tracts of the Syderal Lights: *Pliny* aſcribes that to *Anaximander*,

and next of Thales Mileſius.

lib. 1.

der, a Diſciple of *Thales Mileſius*, (whence he was ſaid *Rerum fores aperuiſſe*, to have opened the Doors of Celeſtial matters) and *Diodorus* to one *Oenopides Chius*: which *Thales* could not yet be ignorant of the Obliquity of the Zodiack, when he had written of the *Solſtices*, and *Equinoxes*, and had converſed a long time with the *Ægyptians* in their own Country, as *Laertius* remembers. Further it is delivered to us, that among others, he predicted that notable *Eclipſe* of the Sun, which hapned in the time of the warre betwixt the *Meads* and *Lydians*; which he could not doe by any other reaſon, but only becauſe, coming newly out of *Ægypt*, he had learned, that *Eclipſes* generally return upon the ſame Day after the ſpace of nineteen Years; and having taken notice of one that fell out 19 Years before, he concluded that there would be one at ſuch a time. Nor is there reaſon why any ſhould think, that otherwiſe his whole life might be ſufficient to obſerve all the motions of the Sun and Moon, as from thence to be able to invent all things neceſſary for the calculation of times of their ſeveral *Eclipſes*. Moreover, it doth not appear, how by any other way, but that *Helicon Cyzicenus* came afterward to fore-tell that *Eclipſe* of the Sun (mentioned in *Plutarch*) for which he was ſo much admired by *Dyoniſius*, and rewarded with a Talent of Gold. Nor likewiſe, how *Sulpitius Gallus* could fore-tell that other of the Moon, which as moſt opportunely predicted to the *Roman* Army, then ready to joyn battel with the *Perſian*, is ſo highly celebrated not only by *Plutarch* and *Pliny*, but alſo by *Valerius Quintilian*, and other Hiſtorians: for other Rule for the calculation of future *Eclipſes*, there was none before *Hipparcus*, who invented Hypotheſes and Tables fit for that purpoſe. Beſides, what *Laertius* imputed to *Anaximander*, *Plinius* as confidently imputes to one *Anaximenes*, an Auditor of his: (namely that he ſhould be the inventor of that *Gnomon*, by which the Converſions of the Sun or the Solſtices and Equinoxes, were indicated; and that he ſet up ſuch a one at *Lacedemon*.) Neer upon the ſame time was it, that *Pythagoras* is ſaid to have firſt diſcourſed (though *Phavorinus*; in *Laertius*, confers that honour upon *Parmenides*,) that *Lucifer* and *Veſper* was one and the ſame Star of *Venus*. Now, whether may we conceive, that he borrowed this of the *Egyptians*, from whom being taught that not only *Venus*, but *Mercury* alſo, were carried round about the Sun, as their Center

in vit. Dionyſ.

them of Pythagoras, *and his Diſciples.*

Center, ſo that one and the ſame might be both Morning and Evening Star: poſſibly, from thence he might take the hint of his Conjecture, that the Sun was the Center of not only thoſe two, but of the other Planets alſo, and conſequently of the whole World: and moreover that the Earth it ſelf, as one of the *Planets*, moved about the Sun? For truly, this was an eminent and conſtant Tenent in his School; as may be underſtood not only from *Ariſtotle* in the general, but alſo from *Laertius* in particular of *Philolaus*, and from *Archimed.* of *Ariſtarchus*, both *Pythagorus* his Diſciples: that we may not rehearſe all thoſe many paſſages in *Plutarch*, concerning this memorable particular; nor name thoſe, who held, that the Earth was not ſo much moved about the Sun, as dayly turned round upon an Axis of its own; as *Timæus*, a *Pythagorian* alſo, who is therefore by *Syneſius* eſteemed, after *Plato*, *the moſt excellent Aſtronomer*.

2. de cœlo. 13. de Arenar. num.

Philolaus, Ariſtarchus, Timæus.

de dcn. ad cæcu. in Timæum.

Furthermore, in the next Age after *Thales*, or neer upon, comes *Cleoſtratus* (the ſame who was beleeved to have deprehended the Signes of the Zodiack) and he, ſeriouſly remarking that the Intercalation, which as we ſaid, was wont to be made every fourth Year, celebrated with the Olimpick Games, did indeed reſtore the motion of the Sun to the ſame day again; but did not reſtore the motion of the Moon till the eight Year, or two Olympiades, in which the Intercalatory Daies amounted to ninety Daies, or three moneths: He, we ſay, thereupon interduced, inſtead of the *Tetaeteris*, or ſpace of four Years, the *Octaeteris*, or ſpace of eight Years, which compleatly paſt, the New-Moons, and Full-Moons would return again on the ſame Daies But, when in ſhort time men had perceived, that this Inſtitution failed them, in exactneſs of computation: and that ſundry waies had bin attempted to cure this uncertainty: at length riſeth up *Meton*, ſomwhat more ancient than *Eudoxus*; and he demonſtrateth from the New-Moons, and Full-Moons Eclyptical, that they did not return upon the ſame Daies, till after full nineteen Years: and thereupon he became the Author of the *Enneadecaeteris*, or *Period*, or *Cycle* of 19. Years. In reſpect of which diſcovery, together with the Heliotrope, or Sun Dyal he made at *Athens*, and ſome other the like Inventions, he was in eminent eſteem among the *Athenians*. But as concerning that *Period*; *Callippos*, familarly acquainted with *Ariſtotle*, diſcovering it to be too-long, by the fourth part of a Day; inferred, that from four Periods

After theſe ſucceeded Cleoſtratus.

Meton, &c.

riods one whole Day ought to be detracted: and ſo erected a new Period or Cycle of Sixty ſix Years, or four times nine, at the end of which, one Day was to be cut off; and this was called the *Callippik Period*, and remained in uſe for a long time together. After him ſucceded *Hipparchus*, who detecting this *Period*, to be yet too long; demonſtrated that after four *Callippik Periods*, or three hundred and four Years, there would remain one whole Day too much. And in truth, the experience of many ſucceding Ages declared, that to this detraction of *Hipparchus*, nine or ten Years over and above were to be expected. However, it is worthy our notice, that the *Period* of *Meton*, together with the Conection of it, applyed by *Callippus*, was of long uſe in the Church, under the name of the *Golden number*: though wanting the Application of *Hipparchus* his Correction: alſo, a miſtake of about four Dayes, relating to the New and Full Moons, crept into the account, even from the time of the *Nicene* Councel; which was one of the two main cauſes of the Reformation of the Kalender in the eighty ſecond Year of the laſt Age.

Artic. 7. Eudoxus, *who firſt diſcovered the neceſſities of many fold* Spheres.

And now we have an opportunity to ſpeak more expreſſly of *Eudoxus*, ſo frequently mentioned. This man, well underſtanding after his return out of *Egypt*, that not only the Sun and Moon, but alſo the five Errant Stars, did keep their courſes round in the Zodiack; and ſo, as that aſwell the Sun and Moon, as thoſe wandering Stars did ſometimes vary their Latitude, or deviate from the *Ecliptick* Line in the middle of the Zodiack: (for, he thought the Sun was alſo extravagant, as well as the reſt; and again, that the other Planets did not only go forward, but were alſo ſometimes upon their retreat backward; and ſometimes made a hault or ſtood ſtill: we ſay pondering all thoſe various motions, in his mind, and caſting about what might be the reaſons thereof in nature; he at laſt imagined to himſelf, that beſides the *Aplanes* or Sphear of fixt Stars, which being ſupreme, carried all the reſt toward the *Weſt*, there ought alſo to be allowed three other Sphears, aſwell to the Sun as to the Moon, and four to each one of the other Errant Stars; of which one and that the higheſt, ſhould follow the Impreſſion of the Fixt Stars, or rather of the *Primum Mobile*; the next to that ſhould move counter to the Firſt, or toward the *Eaſt*; the third make the deviation from tthe *Ecliptick*, or middle of the Zodiack; and the fourth, or loweſt, cauſe in the Stars their Direction, Station or retrogradation, and that

by

by a certain Vibration, or Waving to and agen. So that he ſuppoſed in all, twenty ſeven *Spheres*, and all thoſe Concentrical, that the Superior might carry on the Inferior, and theſe might be turned round within thoſe. Afterwards, *Callippus* adjoyned two *Spheres* to the Sun, two to the Moon, and one a peece to *Mars*, *Venus*, and *Mercury*; and ſo made thirty three: And *Ariſtotle*, to all the *Spheres*, which did not follow the motion of the *Aplanes*, or *Primum Mobile* (exceping only the Lunar *Spheres*) added as many more, which he called the Revolvent ones, to the end he might conform them to the motion of the Inerrant *Sphere*, or *Primum Mobile*: and ſo in the whole he conſtituted Fifty ſix *Spheres*; for as much, at leaſt, as we can collect from his own context. Now all theſe, and even *Plato* himſelf likewiſe, thought that the Moon was the loweſt of all the *Planets*; next to her, the Sun; and above the Sun the five wandering Stars: Nor indeed doth it appear, that *Archimedes* himſelf Living a whole Age or two after them, repreſented the *Planets* in any other, than this very order, in that ſo famous *Sphere* of his. In which though *Claudian* tells us, that no more was repreſented, but only the motions of the Sun and Moon;

Percurrit proprium mentitus Signifer annum,
Et ſimulata novo Cynthia menſe redit: *in Epigram.*

Yet *Cicero* adds other motions, when ſpeaking of *Archimedes*, "he ſaith; when he collected together the motions of the *de div. nat.*
"Moon, Sun, and five wandering Stars; he did the ſame as that
"God, who in *Platoes Timæus* framed the World, that one and
"the ſame Converſion might regulate ſundry motions, moſt dif-
"ferent each from other in ſlowneſs and ſwiftneſs. But *Hipparchus* afterwards finding, that aſwell the Sun as the Moon and the other five Stars did come ſomtimes neerer to the Earth, and ſomtimes again mounted up farther from it; and plainly perceiving that that particular apparence could not poſſibly be explicated by thoſe *Spheres*, that were all Concentrical to the Earth: therefore, wholly rejecting them, he reſolved, that the motions of the *Planets* were to be accounted Eccentrick; and though he could not himſelf determine each particular, he yet demonſtrated the way, in which *Ptolomy* afterwards inſiſting, accompliſht

the Invention. But before we advance further, we are to commemorate two or three Perſons of note, by whoſe Obſervations both *Hipparchus* and *Ptolomy* profited very much. One was *Timocharis*, who about three hundred Years before Chriſt, among other things relating to the Fixt Stars, obſerved that that Star which is called *Spica Virginis*, doth antecede the point of the *Autumnal Equinox*, by eight degrees. And with him are we to joyn *Ariſtillus*, whoſe Obſervations of ſome thing about the Fixt Stars *Ptolomy* made great uſe of, in order to his demonſtrating that the Fixt Stars never chang their latitude. Afterwards (ſcarce an Age) ſucceded *Eratoſthenes*, who being *Library-keeper* to *Ptolomy Evergeta* the former, perſwaded him to ſetup the *Armillæ* in the *Porticus* of *Alexandria*; which *Hipparchus* and *Ptolomy* afterwards made uſe of; and himſelf among other things obſerved, that the Obliquity of the Zodiack was of twenty three degrees, and fifty, one minutes; which account *Hipparchus* and *Ptolomy* conſtantly adhered to.

Ptolom. *lib.* 1. *cap.* 11.

Articl. 8. Hipparchus, *who firſt obſerved the places of the Fixt Stars, according to Longit. and Latitude.*

Now that we may at length remember the great *Hipparchus*, who floriſh't neer upon an hundred and forty Years before Chriſt: truly, we find it no eaſy task to recount, how highly *Aſtronomy* was beholding to him. For, in the firſt place, examining that foreſaid Obſervation of *Timocharis*, with ſome others; albeit he could not conceive them to be in all points exact, yet becauſe himſelf had found that *Spica Virginis* did not antecede the Equinoctial point by more than ſix degrees, and the other Stars in the like proportion: he hence underſtood, that the Fixt Stars alſo were moved Eaſtward according to the Zodiack; and thereupon wrote a Book, of the *Tranſgreſſion of the Solſtices & Equinoxies*. And, being that in his time, as not long ago in *Tycho Brahe*, there appeared a certain New Star, he "therefore came to doubt (to ſpeak the language of *Pliny* concerning him) whether the like happened often or not; and "whether thoſe Stars, that were thought to be fixt, had alſo ſome "certain motion peculiar to themſelves. Wherefore (as the ſame "*Pliny* goes on) he attempted a task of difficulty ſufficient even "for the Gods themſelves, namely to number the Stars for Poſte-"rity, and reduce the heavenly Lights to a rule, ſo that by the help "of Inſtruments invented the particular place of each one, together "with its magnitude, might be exactly defined: and whereby men might diſcern, not only whether they diſappeared, or "newly

Lib. 2. *cap.* 25.

" newly appeared, but alſo whether they removed their Stations;
" as likewiſe, whether their magnitude encreaſed, or diminiſhed;
" Leaving Heaven for an Inheritance for the Witts of ſucceeding
" Ages, if any were found acute and induſtrious enough to com-
" prehended the myſterious orders thereof. And this was the
firſt time when the places of the Fixt Stars were obſerved and
markt out according to *Longitude* and *Latitude*: and that Ca-
talogue of the Fixt Stars, which he compoſed, is the very ſame,
which *Ptolomy* afterward inſerted into his *Almageſt*. In the *l.b 7 cap.*
next place, he denoted what poſitions ſundery Stars had in reſpect
each of other; whether they were poſited in a right Line; or in *ib d cap. 1.*
a triangular form; or in quadrate or ſquare, &c. as is mani-
feſt even from *Ptolomy* himſelf. Further, through the motions
of Sun and Moon were already in ſome meaſure known; he yet
made that knowledge much more exact. For, he did not only *He alſo corre-*
much correct the *Callippick Period*, formerly ſpoken of, but alſo, *cted the* Cal-
having collected a long Series of *Eclipſes* (namely, from the *lippick Peri-*
time of thoſe *Babyloniſh* ones, in the daies of *Mardocem*: *od, and predi-*
pades, down to thoſe obſerved by himſelf, for full ſix hundred *clipſes.* *for*
Years together,) and remarking, that neither the like *Eclipſes* *600. Years to-*
did return on the ſame daies, after the ſpace of every nineteen *gether.*
Years, nor that after ſome recurſes often *Novennales*, or ten times
nine Years, any ſuch *Eclipſes* happened at the times ſuppoſed;
and that the cauſe thereof conſiſted both in the various Latitude
of the Moon, and the anticipation of her *Nodi* or Knotts,
and her Eccentricity, by reaſon whereof her motions to her *Æ-*
pogeium were found to be ſometimes ſlower, and thoſe to her
Perigeum more ſpeedy: therefore, we ſay, He comprehended
and gave Reaſons for all theſe difficulties, and compoſed certain
Hypotheſes, and according to them, certain Tables, by which he
could ſafely and exactly calculate and predict what *Eclipſes*
were to follow how great they were, and when. And this
was it which *Pliny* remembred, when having ſpoken of *Thales*;
and *Sulpitius Gallus*, he comes to mention *Hipparchus*, After
" theſe (ſaith He) *Hipparchus* foretold the courſes of both Lu-
" minaries, for ſix hundred Years to come; comprehending the
" months, Days and hours of Nations, and the Scituations of
" Places and turns of People: his age teſtifying that he did all
theſe great things, only as he was partaker of natures Councels.
For, it muſt be that *Hipparchus*, beſides the preciſe times, when ſuch

or such *Eclipses* were to be visible to the Horizon of *Rhodes*, or *Alexandria*, pointed forth also some Countries, and principal Cities, together with the Designation of the Months in use among them; as also the very Days and hours when each *Eclipse* would happen; and other prædictions succeding to *Rome*, in the Days of *Plyni*.

Again, it is well worthy our recital, that *Hypparchus* labouring with long desire both to constitute *Hypotheses*, and reduce into Tables the motions of the other *Planets*, or five wandering Stars; and yet not being able to furnish himself either from the *Egyptians*, or from his Country men the *Grecians*, with any competent Observations respective to those *Planets*, (for while the places of the Fixt Stars remained unknown, it was impossible any such could be made) and again those he had himself made, were of much shorter time, than was requisite for the establishing any thing certain and permanent in that sort: He therefore only digested such Observations as he had recorded by him into the best order and method he could devise; and so left them for their use and improvement, who should come after him, in case any were found capable of understanding and advancing them. And at length, by good fortune, it so fell out, that those his Observations came into the hands of *Ptolomy*; who comparing them with his own, and finding them judicious and exact, thereupon first began to erect both *Hypotheses* and Tables of Motions fit for those *Planets*: yet not without much timerousness and diffidence; because his Observations being but few, nor of sufficient time, he durst not promise himself any certainty of his Tables for any considerable space, or number of Years. But for more assurance let us hear his own ingenious Confession in that point. The Time (saith He) from whence

Amag. lib. 9 c. 2.

"we have the Observations of the *Planets* set down, is so vastly "short in comparison of the greatness of Coelestial vicissitudes, "as that it renders all predictions, that are for any great number "of Years to come, infirm and uncertain. And therefore I "judge that *Hipparchus* (that zealous lover of truth) considering "this difficulty, and withall receiving not so many true Observa- "tions from the Ancients, as he bequeath'd to us, undertook "indeed the business of the Sun and Moon, and demonstrated "that it might be performed, by equal and circular motions: yet, "as for that of the *Planets*, those Commentaries of his which "have come into our hands, clearly shews, that he attempted it

"not

" not: but collecting all his own Observations concerning, them " together, in one order and method, for their more commodi- " ous use, resigned them to the industry of after times; having " first demonstrated, that they were not congruous to those *Hypo-* " *theses*, which the *Mathematicians* of those Daies made use of. " And, for Others, sure I am, that either they demonstrated no- " thing at all, or else only attempted the business, and left it un- " finisht. But, *Hipparchus* being eminently knowing in all kinds " of learning, conceived, that he ought not (as others had done " before him) to attempt, what he should not be able to accom- plish. So that we see, *Ptolomy* was the first, who from true Obser- vations, reduced the Motions of the *Planets* into *Hypotheses* and Tables correspondent.

Artic. 9. *Betwixt* Hipparchus *and* Ptolomy, *a. m.* Sosigenes, *of* Alexandria, *by whose help* Jul. Cæsar *endeavored the reformation of the* Calendar.

But before we speak more particularly of him, who lived about an hundred and thirty Years after Christ; forasmuch as in the space of time betwixt *Hipparchus* and *Ptolomy*, these studies so florisht at *Alexandria*, as that *Julius Cæsar* returning thence, brought along with him that *Sosigenes*, by whose assistance he endeavoured the restitution of the *Calendar*, and so may be thought to have propagated the Study of *Astronomy* among the *Romans*: let us reflect a little upon that time, and see what care they then had of Cœlestial matters. In the first place, we are to lay aside the Commemoration of *Sulpitius Gallus* (of whom more than once afore, as one that falls not under this account, concerning whom we may not yet forget, what *Cato* is induced by *Cicero*, saying. While we saw that *Gallus* dye, that familier friend of thy Father, O *Scipio*, who was restles in measuring Heaven and Earth; I say, while we saw him dying even in that Study. How often did Day oppress him, when he had set himself to observe and describe something in the Night? and how often did Night oppress him, when he had begun his Speculations in the Morn? How was he delighted, when he had a long time before predicted to us *Eclipses* of the Sun and Moon? &c. For he was a man clearly singular, and in an Age when so great ignorance and neglect of good Arts tyrannized over mens minds, being himself studious and inquisitive, could not but have borrowed his skill either from *Egypt* or *Greece*, where having obtained a *Series* of *Eclipses*, and the way of deducing them through the circuit of nineteen Years (as we said before) he became able to Calculate them, so as *Cicero* relates. For, as to the rest; how great doe-

doe you think was the ignorance and neglect, nay even contempt of ſtudies of this nature among the *Romans*? Why, truely ſo great, as that *Virgil* could not diſſemble it, in the Poeſy attributed to *Anchiſa*, according to which the *Romans* ſhould indeed come to rule the World; but yet ſhould yeeld to others, in learning to know the Stars, and deſcribe the Heavens.

6 Æneid. . . . . *Cœliq; meatus*
Deſcribent radio, & ſurgentia ſidera dicent.

And *Cato* himſelf is cited by *Agellius* to have left in writing that it was not lawfull to write what is in a Table kept by the High Preiſt, how often ſcarcity of Proviſion woul happen, how often the light of the Sun, or Moon ſhould be darkned: ſo far, ſaith *Gellius*, did *Cato* contemne the Science of *Aſtronomy*, and thought uſeleſs either to know, or fore-tell the *Eclipſes* of Sun and Moon. Furthermore, though from times as high as *Numa*, the *Romans* made ſeveral Intercalations; yet they took all their art of that ſort, from the *Greeks*: and *Pliny* remarks, that in *France*, *Spain* and *Africa*, there was no one man, who could ſo much as tell the Riſing of the Stars. Nevertheleſs we are not to forget, that among the *Gauls* was one *Pythias*, the *Philoſopher* (as *Cleomedes* calls him) of *Maſilia*, who about the time of *Alexander* of *Macedon*, found the proportion of the *Gnomon* to the Solſtitial ſhadow, to be the ſame at *Maſſilia*, as *Strabo* tells us *Hipparchus* had obſerved it at *Byzantium*; who firſt attempted the *Northern Ocean*, and diſcovered the utmoſt *Thule*, in which *Cleomedes* cohærently proves the Summer Tropick to be the ſame with the Polar, or greateſt of allwayes apparent ones: and who (as from his Book, *de Oceano*, may be inferred) was exceedingly curious to find out what was the Poſition of Heaven, reſpective to the variety of Countries and Climates. But, not ſo ſoon to digreſs from the *Romans*; *Pliny* delivers, that in thoſe firſt times of *Rome* being a Common-wealth, the Invention of Dyals was very raw and imperfect: for that they had only the riſings and ſetting noted, out of twelve Tables. That after ſome Years, they added the Meridian, and by the indication of a certain column, the laſt Hour: nor that neither, but only in clear weather, even as long as till the firſt *Punick* Warr. Afterward

1 *Meteor* 7. Pythias Maſſilienſis, a *Gaul. and contempo-rary to* Alex. *of* Maced.

lib. 2. *cap.* 28.

lib. 7. *cap.* 60.

ward they advanced ſo far, as to make one, on two Sun Dyals; but not with lines exactly correſpondent to the hours, untill about an Age after, when *Q. Marcus Philippus* ordered the buſineſs more diligently and ſucceſsfully And, becauſe the hours of the Day remained yet uncertain in dark and cloudy weather, *Niſica Scipio* began to divide the Hours of Day and Night equally by Water diſtilling from Veſſel to Veſſel, and called it *The Dyal within Doores*, in the Year *Urbis conditæ DXCV.* And till then, ſaith *Pliny*, *Populi Romani indiſcreta lux fuit.* And thus much of *Hipparchus*, and ſome *Aſtronomers* betwixt him and the Prince of them all, *Ptolomy.*

Quintus Marcius Philippus, *&c.* Naſica Scipio, Romans.

Artic. 10. Ptolomy, *the true founder of* Aſtronomy *in one intire ſtructure.*

And of him, ſo great is his name, all we need to ſay, is only, that He was the *very founder of the Art, or Science of Aſtronomy.* For, though *Hipparchus* had indeed, as it were hewn out the Stones and Beams fit for ſo noble a Structure, and prepared good part of the Materials; yet was it *Ptolomy* alone who put them into Order and Form, and by adding many admirable Inventions of his own, by infinite labour and coſt, erected that ſo famous Building, worthily called Μεγάλη Σύνταξις, *the great Co-ordination, Conſtruction, or Compoſition*; which conſiſting of no leſs than thirteen Books, contains all the Doctrine, that could then be advanced, concerning the Sun, Moon, and aſwell the Fixt, as wandering Stars. And, albeit one Day teacheth another, and that (as Himſelf had truly foretold) there came others after him, who ſaw good cauſe for the Caſtigation and Correction of many things delivered in that Work: yet, in the general, the Art he had inſtituted, remained firm and conſtant, and was afterwards imbraced, not only by the *Alexandrians*, but alſo by all the *Arabians*, *Latins* and others, who devoted themſelves to the ſervice of *Urania*, ever ſince. For, that the Study of her Cœleſtial myſteries continued in great eſteem and Veneration, at *Alexandria*, for ſome Ages after his deceaſe, may be undeniably atteſted, not only from hence, that (among others) both *Theon*, and *Pappus*, named *Alexandrians*, were eminent therein; of which the one put forth eminent Commentaries upon *Ptolemies* Works, and the other, among ſundry excellent peeces, of which his ſixth Book of *Mathematicall Collections* is one, obſerved, that about four hundred Years from Chriſt, the *Obliquity* of the *Ecliptick* was not ſo great, as *Eratoſthenes*, *Hipparchus* and *Ptolemy* had conceived: but neer upon the ſame we diſcover it to be in our Daies:

Who next reſigned it to Theon *and* Pappus, *both* Alexandrians.

Daies: we ſay, that this is not the only Monument that is extant of the flouriſhing of *Aſtronomy* at *Alexandria*, long after *Ptolomy* had given it ſo great a Reputation there; but there remains another as freſh and lively, which is the memorials of thoſe *Patriarchs* of the *Alexandrine Church*, to whoſe judgement the determination of that great diſpute about the true time of *Eaſter*, was thought fit to be wholly referred, aſwell by the *Nicene Councel*, as by divers learned *Biſhops* afterward, and by *Holy Leo* himſelf, then *Pope*. Now, among theſe *Patriarchs* were *Theophilus*, *Cyrillus* and *Proterius*, whoſe advice and directions were thought neceſſary, in regard that the Controverſies raiſed about the Celebration of *Eaſter*, about the time of the *Vernal Equinox*, about the Full-Moon next following, and about conſtituting certain conſtant Rules reſpective to them; could not be better compoſed, than by the definitive ſentence of theſe Prelates, who Living at *Alexandria*, where *Aſtronomy* was in ſuch Height, had the advantage of others, in point of knowing thoſe things which were requiſite to the finding out of the truth But, of the *Arabians*, who in the Study of *Aſtronomy* ſucceded the *Alexandrians*, and tranſlated into their own language, the *Great Compoſition* of *Ptolomy*, which they called *Almageſtum*; the Firſt, and moſt worthy to be remembred, was *Albategnius* otherwiſe called *Mahometes Aractenſis*, born of a Family of the *Dynaſtæ* of *Syria*; He about 800. Years after Chriſt, made, divers Cœleſtial Obſervations, partly at *Aracta*, and partly at *Antioch*: and found, both that the Apogeum of the Sun, ſince the Daies of *Ptolomy*, was advanced to the following Signes; and that the Stars did regreſs toward the Eaſt, one degree, not in the ſpace of a hundred Years, as *Ptolomy* alſo had deſigned; but of ſomwhat leſs than ſeventy; as alſo, that the Obliquity of the Ecliptick, according to *Pappus* his Theory, was leſs (*viz.* above 23 degrees 35. minutes) with many other particulars concerning aſwell the Fixt Stars, as the Planets: whereupon he both corrected *Ptolomy* in many things, and compoſed new Tables, and wrote a Book intituled, *De Scientia Stellarum*. After him, within 2 or 3 Ages following, ſucceeded *Alphraganus*, *Arzachel*, *Almeon*, and other *Arabians*; among whom, (as being already tainted with that ſuperſtition which had corrupted the ſimplicity of *Aſtronomy*, with *Aſtrological* Fooleries) ſome certain *Jewes*, as ambitiouſly affecting the glory of Divination as the others, intermixed themſelves.

a while after to Albategnius, *then to* Alphraganus *and other* Arabians.

After

After them, for a long time, the Worſhip of *Urania* lay neglected, nor did *Aſtronomy* receive any the leaſt (conſiderable) advantage by Obſervatois; till neer about four hundred Years ſince, *Alphonſus* King of *Caſtile* and *Leon*, being himſelf alſo toucht with the curioſity of *Aſtrological* predictions, and diſcovering that the Tables aſwell of *Ptolomy*, as *Albategnius* were not exactly agreeable with the Cœleſtial motions; ſet himſelf to the compoſing of new ones; and to that purpoſe convocated as many *Arabians* and *Jewes*, as were eminent in thoſe Daies for *Aſtronomy*, imploying them about Obſervations neceſſary to ſo great a Work, and comparing with them thoſe of their Predeceſſors, that ſo they might be the more exact in the performance of their task propoſed. And very memorable it is, that (as hath been credibly reported) He ſpent four hundred thouſand peeces of Gold on that undertaking: a munificence truly worthy the Heroick mind of ſo great a Prince, and which well deſerves to be had in perpetual commemoration by all lovers of Learning: but ſomwhat unhappily imployed, in reſpect the Perſons ſet a Work were not ſo ſtrict in ſtudiouſly and conſtantly obſerving, as ſcrupulouſly computing, directing their calculations not ſo much to what themſelves and others had really obſerved, as to certain traditional, myſteries, or Cabaliſtical dreams: that we may paſs by their heedleſneſs, which *Regiomontanus* detecting, perceived, that they had miſtaken the true places of the Fixt Stars, by very neer two whole degrees; as accounting the numbers of *Ptolomy*, as if they had bin conſtituted by him from the beginning of the Years of Chriſt. Which conſidered, we have the leſs reaſon to wonder, if the Tables compoſed by them, called from the Kings name, the *Alphonſine*, and ſomtimes from the place, where they were made, the *Toletane Tables* (whence alſo He, who was Preſident of that aſſembly of *Aſtronomers*, is ſaid to have been one *Iſaac Chanter* of the *Toletan* Synagogue) have been found, ever ſince the time of K. *Alphonſus*, to diſagree with the Heavens, and to require the review and caſtigation of ſome new and more faithfull hands. Thence forward *Aſtronomy* lay neglected, and almoſt buried in oblivion, (only *Thebitius* an *Arabian*, and *Prophalius* a *Jew*, obſerved in the mean time ſome ſmall matters, about the motion of the Fixt Stars, and the obliquity of the *Ecliptick*,) untill about two hundred Years ſince, *Georgius Peurbacchius*, and *Joh. Regiomontanus*, his diſciple, ſeemed to revive it

Artic. 11. Alphonſus, K. of Caſtile, who made and named the Alphonſine Tables.

after whom, the Science lay neglected. till, Georg. Peurbacchius and Joh. Regiomontanus aroſe,

and again cultivated the ſame.

it. For, theſe worthy men delivered it out of the double cloud of ignorance and vanity, which the *Arabians* and *Jewes* had raiſed, to the Obſervations of its luſture; and kindled the Light thereof afreſh in *Germany*: reducing *Ptolomy*, providing Inſtruments, and making not a few faithfull Obſervations: though they were not ſo happy, as to bring their deſigne to that perfection they hoped and had propoſed to themſelves; both of them dying in the middle and flower of their Age.

Artich. 12. *Then followed the moſt accute* Nich. Copernicus, *who revived the doctrine of* Pythagoras, *concerning the Earths motion.*

Animated by their example, *Nicholaus Copernicus* (a *Boruſſian* born, and *Canon* of the *Cathedral Church* of *Warmes*, ſcituate neer *Fruemburgh*, in the ſame Country) about the beginning of the laſt Age, ſeriouſly addreſſed himſelf to the Illuſtration of *Aſtronomy*; and reviving the long neglected Syſteme of the World excogitated by *Pythagoras*, he made many good Obſervations, in order to the compoſing of new Tables. But, foraſmuch as he could not determine any thing concerning the Fixt Stars, beſides their Promotion Eaſtward, which they appeared to have made ſince *Ptolomy's* time; he therefore compoſed ſome *Canons* of their motions, and thoſe as exact as poſſibly he could: yet both thoſe, and the *Prutenick Tables* that were built upon them, were incorreſpondent to the motions of the Heavens, though leſs incorreſpondent than the *Alphonſine*. Nevertheleſs, the man is to be highly commended, both for his ſublime perſpicuity, and modeſty, in that foreſeeing his *Canons* would need correction, he was wont frequently to exhort and encourage that ingenious young man, *Georgius Joachimus Rheticus*, deeply enamoured of the beauties of *Aſtronomy*, to apply himſelf principally to the Reſtitution of the Fixt Stars, and cheifly of thoſe, which were in the Zodiack, or neer it, and with which the Planets might be moſt conveniently compared: becauſe, without their reſtitution, it was impoſſible either to attain to the true places of the Planets, or to atcheive any thing of Moment or certainty, toward the advance of *Aſtronomy*.

Artich. 13. *And laſt of All, the noble* Tycho Brahe, *who out-did all the reſt in diſcoveries and inventions.*

And then at laſt enters that Noble *Dane*, *Tycho Brahe*, upon the Theatre of *Aſtronomy*. Who, as by in the impulſe of his Genius, be addicted to beholding and noting the Stars, even almoſt as ſoon as he ſaw the light of them; was ſo much the more ſpurred on by that advice of *Copernicus*, publiſhed in the Works of *George Joachim* newly mention'd, by how much the more clearly he diſcerned the impoſſibility of determining the

true

true and proper place of that famous New Star, (appearing in the Conſtellation of *Caſſiopeia*, from the beginning of *November*, in the Year M D. LXXII. for above ſixteen moneths together) without the reſtitution of the Fixt Stars to theirs. For, He pleinly perceived, that moſt, if not all the Errors, which had bin found in *Aſtronomy* even from its firſt foundation or original, took their riſe cheifly from hence, that the Fixt Stars really were not in thoſe places, in which they were ſuppoſed to be, by Obſervators; But ſome of them were much neerer, and others again as much farther off; and this, whether becauſe *Hipparchus* in the beginning had not with due exactneſs conſigned all the Fixt Stars to peculiar places, which indeed he had deſigned by the Sextants of degrees (and truly it is very difficult at once to invent any thing of Moment, and perfect the invention) or whether becauſe the Tranſcribers of *Ptolomy*, out of careleſneſs, or ignorance, had corrupted the Original Text in many places; or whether the additions afterward made; in reſpect of the Stars progreſs to the following Signes, had occaſioned any miſtake and imperfection in that Theory; or whether by any other unhappy cauſe whatever. Now, in Order to this great Work, of rectifying thoſe fundamental Errors, it pleaſed Fate, that about the very ſame time, that truly generous and never enough commendable Prince *William Landgrave* of *Haſſia*, had zealouſly devoted his mind and induſtry to the ſame care, of reſtoring the Fixt Stars to their true manſions: but yet the honour he aimed at, was decreed only for the incomparable *Tycho*; who in an Heroical bravery of Soul, had now reſolved with himſelf to enterpriſe no leſs than the Inſtauration of the whole Science of *Aſtronomy* from its very fundamental,; and ſo to ſpare neither labour, nor coſt (eſpecially while he was ſo happy, as to have good part of his expences defraied by the liberal contributions of that eminent *Mecenas*, *Frederick* the *II.* King of *Denmark*, who thereby recorded his name in immortal Characters on the leaves of Fame) that ſhould be neceſſary to the making all Sorts of Obſervations requiſite. As ſoon therefore as he had furniſhed himſelf with that *Aſtronomical* Colledge, or Tower for Obſervations, built by him in the *Iſland* of *Huenna*, to that purpoſe aſſigned him by the King, and furniſhed that Heavenly Cittadel by him called *Uraniberg*, with ſtore of exquiſite and magnificent Inſtruments Mathematical, he begun (having provided himſelf of

ſundry learned and competent Coadjutors) exactly to obſerve the Altitude of the Pole, in that place, by the Circum-Polary Stars. By which underſtanding likewiſe the Altitude of the *Equator*, he pointed out the Equinoctial points, by the paſſing of the Sun through them: and attending beſides to the middle parts of *Taurus* and *Leo*, he found out the *Apogeium* of the Sun, and the Eccentricity of it, and deduced its Courſe from the point of the *Vernal Equinox*. Moreover, from *Venus*, in the Day time compared with the Sun, and in the Night with the Fixt Stars; he endeavoured to ſearch out the Right Aſcenſions, and Declinations of the Fixt Stars: which the Ancients had performed, but fallaciouſly, by uſing the Moon, not *Venus*, to that purpoſe. And his ſucceſs was as exquiſite as his care in this, that he conſtituted that bright Star which is in the top of *Aries*, and ranged the cheif of thoſe in order along the Zodiack: and then advancing to enquire or rather find out the diſtances of the reſt aſwell from them, as each from other, he defined both the right Aſcenſions and Declinations of all; preſcribed their ſeveral Longitudes and Latitudes, and added to the Catalogue of the Ancients about 200. other Stars, wholly by them omitted. Becauſe the Ancients, Living in an Horizon much more Southern, had obſerved and ſet down neer upon 200. Stars, that are inviſible in the *Daniſh* Horizon, which is highly Northern: and *Tycho* again collected about 200. more than they could diſcern; and as being ſomwhat ſmall, he intermixed them among others of greater magnitude. Further, having in the mean ſpace, alwaies obſerved the paſſings of all the Planets through the Meridian, and their ſeveral diſtances from the cheif Fixt Stars neereſt to them: he laid ſuch ſolid foundations, as by them might be exactly known not only the true places of each, but alſo their ſeveral Motions. So that he came very neer the heighth of his noble hopes of building the whole Theory of *Aſtronomy* anew from the very ground, and of erecting compleat and everlaſting Tables for Calculation thereupon: but alas! prevented by an immature death, He could not accompliſh his deſigne. It was very much, however, that He went ſo far, as to have recorded and bequeathed to Poſterity ſuch excellent Obſervations, by which *Kepler* was ſoon after enabled to compoſe an intire Theory, and make the Tables called the *Rudolphine*; and by which, and others afterward contriveable, whatever can be deſi-

red.

red in theſe Tables, may be fully ſupplyed and perfected. And this among the reſt deſerves ſingular commendations, that He left us the Fixt Stars re-inſtalled in their true manſions: wherein He alone, in few Years practice, performed and finiſhed that prodigiouſly great Work, which no man from the Daies of *Hipparchus*, had either attempted, or in any meaſure advanced.

I paſs by many other admirable diſcoveries of his as that he was the firſt who demonſtrated all Comets to be carried freely through the Etherial Spaces; that Refractions ought to be carefully conſidered and allowed for, and how; that he perceived that the *Latitude* of the Moon ought to be augmented by more than a Quadrant, or fourth part, than had been conceived; that He almoſt demonſtrately convinced the Latitudes of the Fixt Stars to be varied; that he excogitated an *Hypotheſis*, which all thoſe who cannot allow of the *Ptolomaical*, for fear to allow the *Copernican*, may well adhere to and defend; with many other things, as difficult in their invention, as excellent in their uſe And obſerve only, how vaſtly he tranſcended all that went before him, in point of exactneſs and certainty. As for *Inſtruments Mathematical*, it is well known, He made ſuch, as for the condition of their matter, for the Vaſtneſs of their magnitude, for the variety of forms, for the care of their elaboration, for the preciſeneſs of their diviſions, and for the facility in uſeing; as the World had never the like before. Again, ſo prodigious was his and his Coadjutors ſubtility, diligence, induſtry; that whereas the Obſervations of *Hipparchus*, *Ptolomy*, and all others before him had bin marked out only by the Sixth or at moſt by the twelfth part of degrees; he deſigned all his by the Sixtieth parts of degrees, called Minutes, or Scrulpes, and very often alſo by ſubdiviſions of Minutes. So that we may well demand what compariſon can be made betwixt that groſs way found out by *Eraſtothenes*, and approved and followed afterward by *Hipparchus* and *Ptolomy*, for the Obſervation of the Obliquity of the Zodiack; and that moſt fine and exact one invented by *Tycho*? His being, by a diviſion of the Meridian into 83 parts, and the Interval of the Tropicks deprehended to take up 11. of them, it appeared that the diſtance of one Tropick from the *Equator*, amounted to 5. of thoſe parts and a half, or by a reduction of them again to degrees of 23 degr. 51. Min. and $\frac{1}{3}$ parts, and theirs being by an hollowed Hemiſphear of Stone, with a Gnomon erected in the

the middle, as we have formerly deſcribed it; and to what degree of ſubtility and exactneſs this way of commenſuration could arrive, the meaneſt Novice in *Aſtronomy* may ſoon judg. That *Quadrant* likewiſe of *Ptolomy*, ſo much admired by ancient Authors; Pray, How vaſtly ſhort did it come of the perfection of the leaſt that *Tycho* uſed? And the ſame may be ſaid of his *Rules*; for, that thoſe *Armilla*, ſet up by *Ptolomy* in the entrance of *Alexandria* had any thing in them comparable to thoſe erected by *Tycho* in his *Uraniburg*, cannot be in the leaſt meaſure be argued from the other Inſtruments then in uſe, It is not neceſſary, we ſhould here again review thoſe machinaments, or engines, which the old *Egyptians* and *Babylonians* made uſe of, either in diſcerning the Signes of the Zodiack, or taking the Diameter of the Sun: or thoſe, which *Ariſtarchus* and *Archimedes* uſed, for commenſurating the ſame Diameter. Only we cannot but wonder. by the by, how *Ariſtarchus*, having aimed ſo neer the white of truth, in the matter of the Suns Diameter, and determining it to be the 720th, part of the Circle, or half a degree; as is dilivered by *Archimed*: ſhould yet err ſo widly in his book of *Magnitudes* and *Diſtances*, as to make the Diameter of the Moon (which in truth; is very neer as great as that of the Sun) to be the 18oth, part of the Circle, or 2. degr. when he called it *the Fifteenth part of a Signe*; which miſtake of his was long ſince taken notice of by *Pappus*. Nor is there any neceſſity, why we ſhould ſurvey thoſe Inſtruments, that *Albategnius*, *Purbachius*, *Regiomontanus*, *Copernicus*, and other more moderne *Aſtronomers* uſed: conſidering, that beſides the *Rules* made by *Regiomontanus* (which *Bernardus Waltherus*, his diſciple, preſerved, and had recorſe to, in his Obſervations of the Suns Altitude) they came ſo ſhort of the leaſt of *Tychoes*, in point of exact reaſoning, and amplitude, that they deſerve rather to be perpetually forgotten, than remembred to competicion. However it is ſeriouſly to be wiſhed, that the Obſervations made by thoſe incomparable inſtruments of His, may ly no longer concealed from the World (for by ſingular Providence, they have been hitherto preſerved, as *Gaſſendus* atteſteth, *in the life of Tycho*) but ſoon be brought to Light. And this aſwell for ſundry weighty Conſiderations there alleadged by *Gaſſendus*; as for this, that not all the Stars, of which *Tycho* hath given a copious Catalouge in his *Progymnaſmata*, may be found reduced to congruous Calculation (in as much as they doe

de Axiomatum

not

not exactly correspond with the heavens) and that various Catalogues have been pretended from the same, which are very much different each from other: for all the difficulties hereupon depending may soon be removed, and all mistakes rectified, by having recourse to the Fountain, or Original observations, which will clearly declare, what hath bin already corruptly deduced, and what may be at length carefully and demonstratively deduced from them.

And, in the mean while, if *Hipparchus* his memory be so highly and (indeed) justly precious among learned men, for his great merrits in excogitating and framing Instruments, whereby to take the dimensions, distances, motions &c. of Heavenly bodies: certainly, that of our *Tycho* ought to be as highly esteemed by us and all Posterity; since he alone, for so many Ages together was found, that durst not only imitate him in those sublime inventions; but so imitate, as very much to exceed him. For my part, truly; since *Hipparchus* may rightfully be called *Atlas the Second*: I shall do but justice to name *Tycho*, *Hercules the Second*, who releiving his Predecessor, long languishing and ready to faint under so prodigious a burden; which doubtless was the Reason, why *Kepler* called him, the *Modern Hipparchus*.

And thus have we in a short Relation, rehearsed to you, what we could gather together, concerning the Original, Progress, and Advance of *Astronomy*, from the highest of times, of which there remain any Authentick memorials, down to the decease of *Tycho Brahe*, the Noble and the Great. As for what *Additions* this excelent Science hath received, by the industry of *Astronomers* in this present Age, by the help of the *Telescope*, whose Invention may seem to have been unhappily deferred too long, as being deferred till some Years after *Tychoes* death: they may be easily summed up. For all that our Days can justly challenge the honour of discovering, is (1.) the spots in the Sun (2.) the inequality of the superficies of the Moon: (3.) *Venus* shifting her apparences, as doth the Moon: (4.) *Mercury* and *Jupiter* in some Proportion, doing the like: (5) *Jupiter* with a kind of a bound about him, and guarded with four lesser Stars as Attendants: (6.) *Saturn* triple-bodied: (7.) the *Gallaxy* fully beset with small Stars: and (8) divers pale assemblies of small Stars seeming to be only little white clouds in the *Wilkin*; with some other particulars lately remarked. Now if you please to ad this to the former summary: you have the whole (though brief) Story of *Astronomy*,

nomy, from its very infancy to that augmented state it now hath attained: I wish I might have said, to its *Full growth and Perfection*. But, alas! that is reserved for Posterity.

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